6. CHEMISTRY

6.1 Perched Water

Historical sampling of water from the perched water wells at INTEC has shown varying levels of chemical contaminants within the perched water zones. Contamination within the perched water zones was recorded as early as the late 1950s during drilling of several wells in the INTEC vicinity. Table 6-1 shows the depth of perched water that was encountered and its chemical characteristics (Robertson et al. 1974).

Shallow perched water wells constructed at INTEC from 1990 to 1994 also encountered various degrees of chemical contamination. The chemistry data from these wells are presented in the WAG 3 RI/FS work plan (INEEL 1995).

Water sampling and analysis were conducted on INTEC wells during the spring and summer of 2001. Data from the water sampling of perched water wells are included as Appendix C. Tables 6-2 through 6-4 summarize the radiological, inorganic, and metals data, respectively. Only those wells from which a sample could be obtained are included in Tables 6-2 through 6-4 (wells not included were dry at the time of sampling). The only organic compound identified without a data qualifier flag was methylene chloride from well PW-1 at a concentration level of 7 μg/L. An additional five samples were identified to contain organic constituents with J flag qualifiers. These detections are shown in Table 6-5.

Figures 6-1 through 6-3 show the location of the perched water wells and the levels of measured selected chemical contaminants within the shallow perched water zone.

Table 6-1. Perched water encountered during drilling of early wells and its chemical characteristics (from Robertson et al. 1974).

Well Number	Date Drilled	Depth to Perched Water (ft)	Characteristics of the Water	Depth of Perching Clay Layer (ft)
USGS-40	Sep-56	348 (rose to 340)	High Na^+, Cl^-	370
USGS-41	Dec-56	396 (rose to 384)	High Cl^-	?
USGS-43	Mar-57	367 (rose to 362)	Normal chemical composition	370
USGS-44	Sep-57	385	Normal chemical composition	?
	Sep-59	84		110?
		126	High sodium, beta activity, RU-106, Rh-106 present	135
USGS-50	Deepened to 405 ft in Oct-62	390	High H-3	392
	Dec-59	174	Slightly high Na^+, high beta and gamma activity, I-131, Ru-106, Rh-106 present	195
USGS-52	Deepened to 650 ft in Oct-60	320		345
		385	Slightly high Na^+, high beta activity, RU-106 present	410

Table 6-2. Summary of key parameters for radiological chemistry in INTEC perched water.

	I-129 (pCi/L)			Pu-238 (pCi/L)			Pu-239/240 (pCi/L)			Sr-90 (pCi/L)			Tc-99 (pCi/L)			Tritium (pCi/L)		
Well[a]	Result	Result Uncertainty[b]	Q Flags	Result	Result Uncertainty[b]	Q Flags	Result	Result Uncertainty[b]	Q Flags	Result	Result Uncertainty[b]	Q Flags	Result	Result Uncertainty[b]	Q Flags	Result	Result Uncertainty[b]	Q Flags
37-4 (100–110 ft bgs)	-0.008	0.045	U	3.02E-03	3.00E-03	U	6.03E-03	4.30E-03	U	2.99E+01	4.30E+00		-1.33E-01	2.30E+00	U	7.09E+02	1.10E+02	U
55-06 (93–113 ft bgs)	-0.025	0.046	U	1.83E-02	9.48E-03	U	5.22E-03	3.70E-03	U	5.34E+04	7.20E+03		9.42E+01	3.83E+00		2.42E+02	8.35E+01	UJ
Big Lost River Well A (32.3 ft bgs) (lysimeter sample)	NA			NA			NA			-2.62E+00	4.40E-01	U	NA			NA		
Big Lost River Well B (167 ft bgs) (lysimeter sample)	1.76E+01	3.26E+00	UJ	NA			NA			-1.25E+01	1.96E+00	U	-2.79E+01	1.38E+00	U	-2.21E+01	1.24E+02	U
Big Lost River Well C (375–385 ft bgs)	-0.076	0.048	U	0.00E+00	1.00E+00	U	0.00E+00	1.00E+00	U	1.24E-01	1.90E-01	U	-5.15E-01	2.40E+00	U	-1.55E+01	1.10E+02	U
Central Set Well B (159–164 ft bgs)	-0.054	0.045	U	-1.97E-03	4.40E-03	U	-2.34E-10	2.78E-03	U	-3.44E-01	1.38E+00	U	1.06E+01	2.46E+00		7.76E+02	1.14E+02	
Central Set Well B (122 ft bgs) (lysimeter sample)	-3.31E+00	1.65E+00	U	-4.14E-02	3.65E-01	U	3.07E-01	3.62E-01	U	-4.97E+00	6.20E-01	U	-9.24E+00	4.56E-01	U	1.88E+02	1.27E+02	U
Central Set Well C (280 ft bgs) (lysimeter sample)	1.89E+00	1.47E+00	U	-3.86E-01	8.39E-01	U	-6.79E+00	1.08E+00	U	-2.85E+02	4.50E-01	U	-5.31E+00	2.62E-01	U	8.31E+02	1.35E+02	
MW-1 (359–369 ft bgs)	-0.003	0.043	U	-2.20E-03	1.01E-02	U	-1.05E-09	5.38E-03	U	4.57E+00	7.05E-01		2.37E+00	2.44E+00	U	1.26E+04	7.06E+02	
MW-10 (141–151 ft bgs)	NA			NA			NA			1.72E+04	3.35E+03	UJ	4.57E+02	9.15E+00		1.59E+04	8.78E+02	J
MW-17 (182–192 ft bgs)	-0.011	0.042	U	-5.82E-03	4.10E-03	U	2.90E-03	5.00E-03	U	7.27E-01	2.80E-01	U	1.56E+00	2.50E+00	U	4.04E+04	2.20E+03	
MW-18 (394–414 ft bgs)	NA			NA			NA			NA			NA			3.49E+04	1.89E+03	
MW-2 (102–112 ft bgs)	0.172	0.06	J	5.01E-02	1.07E-02		1.30E-02	5.60E-03	UJ	1.36E+05	1.82E+04		1.93E+01	2.69E+00		2.06E+03	1.66E+02	
MW-20 (133–148 ft bgs)	-0.044	0.046	U	4.22E-03	4.23E-03	U	0.00E+00	1.00E+00	U	2.07E+04	2.90E+03	J	9.45E+00	2.69E+00		3.31E+02	9.00E+01	
MW-24 (53–73 ft bgs)	-0.02	0.028	U	3.27E-02	4.43E-02	U	-1.03E-02	1.04E-02	U	8.82E-01	1.47E-01		-1.13E+00	2.21E+00	U	8.06E+01	1.01E+02	U
MW-5 (106–126 ft bgs)	0.179	0.059		3.39E-03	4.15E-03	U	0.00E+00	1.00E+00	U	1.84E+04	2.14E+03	J	4.38E+00	2.48E+00	U	1.41E+03	1.25E+02	
MW-6 (117–137 ft bgs)	0.012	0.028	U	-6.03E-03	6.04E-03	U	2.39E-02	1.69E-02	U	9.00E-01	1.85E-01		1.41E+00	2.22E+00	U	1.98E+02	1.05E+02	U
Percolation Pond Well B (180–182 ft bgs)	0.284	0.073		-1.76E-03	3.06E-03	U	-1.76E-03	3.05E-03	U	2.00E+00	3.19E-01		4.45E+00	2.53E+00	U	7.37E+02	9.99E+01	
PW-1 (100–120 ft bgs)	0.008	0.029	U	0.00E+00	1.00E+00	U	-1.07E-02	7.61E-03	U	2.37E+00	2.57E-01		3.65E-01	2.46E+00	U	-1.85E+02	8.06E+01	U
PW-2 (111–131 ft bgs)	0.139	0.033		1.33E-02	1.34E-02	U	6.93E-03	1.48E-02	U	1.76E+00	2.37E-01		1.51E+00	2.56E+00	U	1.41E+02	8.66E+01	U
PW-4 (110–150 ft bgs)	0.128	0.033		-5.63E-03	5.64E-03	U	1.17E-02	1.18E-02	U	1.15E+00	2.10E-01		4.34E+00	2.69E+00	U	-1.29E+02	8.20E+01	U
Duplicate of PW-4 (110–150 ft bgs)	0.041	0.03		NA			NA			NA			NA			NA		
PW-5 (109–129 ft bgs)	0.07	0.025	U	0.00E+00	1.00E+00	U	-1.23E-02	1.23E-02	U	1.59E+00	4.84E-01		2.00E+00	2.82E+00	U	-7.64E+01	8.25E+01	U
Sewage Lagoon Treatment Well A (26 ft bgs) (lysimeter sample)	1.04E+01	5.52E+00	U	-1.47E-01	3.41E-01	U	-1.92E-02	3.07E-01	U	-5.90E+00	9.30E-01	U	-1.95E+01	9.64E-01	U	2.66E+04	1.28E+02	J
HLLW Tank Farm Well A (34.5 ft bgs) (lysimeter sample)	1.22E+01	3.83E+00	UJ	6.05E-02	3.33E-01	U	-1.88E-01	4.01E-01	U	4.25E+00	4.00E-01		3.39E+00	1.67E-01		9.72E+01	1.25E+02	U
HLLW Tank Farm Well B (118 ft bgs) (lysimeter sample)	1.23E+01	1.79E+00	UJ	-8.40E-02	3.28E-01	J	-6.30E-02	3.31E-01	U	5.28E+00	7.00E-01		-5.53E-01	2.73E-02	U	7.07E+01	1.25E+02	U
USGS-50 (357–405 ft bgs)	0.65	0.065		5.34E-02	3.80E-02	U	1.07E-03	3.23E-02	U	1.59E+02	5.14E+00		5.20E+01	3.19E+00		3.29E+04	1.91E+03	
USGS-50 (357–405 ft bgs)	0.62	0.065		1.19E-02	1.20E-02	U	6.21E-03	1.32E-02	U	1.74E+02	8.82E+00		5.02E+01	3.19E+00		3.48E+04	2.02E+03	

a. ft bgs – depth below ground surface of the open interval in the well.
b. Result Uncertainty - +/- 1 standard deviation.

Table 6-3. Inorganic chemistry of the INTEC perched water.

Analyte (mg/L)	Well 37-4 (100–110 ft bgs) Results	Flags	Well 55-06 (93–113 ft bgs) Results	Flags	Big Lost River Well C (375–385 ft bgs) Results	Flags	Central Well B (159–164 ft bgs) Results	Flags	Central Well B (122 ft bgs) Lysimeter Data Results	Flags	Central Well C (280 ft bgs) Lysimeter Data Results	Flags	Well MW-1 (326–336 ft bgs) Results	Flags	Well MW-17 (182–192 ft bgs) Results	Flags	Well MW-2 (102–112 ft bgs) Results	Flags
Bromide	0.283		0.148		0.129		0.267		0.944		0.500	U	0.1	U	0.104		0.1	U
Chloride	31.8		67.2		7.06		94.5		192.5	E	29.6	E	52.6		25.8		39.4	
Fluoride	0.263		0.166		0.312		0.283		0.500	U	0.638		0.207		0.274		0.266	
Nitrate-N	27.9		22.4		0.907		8.14	J	313.0	E, R	0.500	U, R	60.3		4.87		5.92	
Nitrite-N	0.1	U	0.1	U	0.1	U	0.1	U,UJ	0.500	U, R	0.500	U, R	0.1	U	0.132		0.1	U
Phosphate	0.1	U	0.162		0.1	U	0.1	U,UJ	0.500	U, R	0.500	U, R	0.1	U	0.135		0.1	U
Sulfate	73.0	E	34.4	E	23.7	E	52.9		134.0	E	23.2	E	27.3		54.3	E	21.2	
Silica	8.04		9.83		11.3		7.96						8.62		9.62		12.0	

Analyte (mg/L)	Percolation Pond Well B (180–182 ft bgs) Results	Flags	Well PW-1 (100–120 ft bgs) Results	Flags	Well PW-2 (111–131 ft bgs) Results	Flags	Well PW-4 (110–150 ft bgs) Results	Flags	Well PW-5 (119–129 ft bgs) Results	Flags	Sewage Treatment Lagoon A (26 ft bgs) Lysimeter Data Results	Flags	Tank Farm Well A (34.5 ft bgs) Lysimeter Data Results	Flags	Tank Farm Well B (118 ft bgs) Lysimeter Data Results	Flags	USGS 50 (357–405 ft bgs) Results	Flags	USGS 50 (357–405 ft bgs) Results	Flags
Bromide	0.106		0.1	U	0.1	U	0.1	U	0.1	U	0.500	U	0.500	U	0.500	U	0.1	U	0.1	U
Chloride	248.0		155.0		179.0		154.0		161.0		31.5	E	26.8	E	11.0	E	58.9		59.8	
Fluoride	0.268		0.187		0.218		0.183		0.183		0.500	U	2.66		0.500	U	0.262		0.236	
Nitrate-N	1.30		0.767		0.885		0.650		0.860		488.0	E, R	0.500	U, R	128.0	R	36.5		36.5	
Nitrite-N	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	12.9	R	0.500	U	4.3	R	0.1	U	0.1	U
Phosphate	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.500	U, R	1.38	R	0.500	R	0.1	U	0.1	U
Sulfate	36.5		33.7		33.8		34.8		31.4		212.0	E	32.0	E	150.0	E	42.9		41.7	
Silica	11.2		10.1		11.1		9.65		10.6								11.6		12.8	

Table 6-4. Summary of key metals analytical results within INTEC perched water.

Analyte	Well 37-4 (100–110 ft bgs)		Well 55-06 (93–113 ft bgs)		Big Lost River Well C (375–385 ft bgs)		Central Set Well B (159–164 ft bgs)		Central Set Well B (122 ft bgs) Lysimeter Data		Central Set Well C (280 ft bgs) Lysimeter Data		Well MW-1 (326–336 ft bgs)		Well MW-17 (182–192 ft bgs)		Well MW-2 (102–112 ft bgs)		Well MW-20 (133–148 ft bgs)	
	µg/L	Flags	µg/L	Flags	µg/L	Flags	µg/L	Flags	µg/L	Flags	µg/L	Flags	µg/L	Flags	µg/L	Flags	µg/L	Flags	µg/L	Flags
Cadmium	5.0	U	5.0	U	5.0	U	5.0	U	12.0	B,U	23.0	B	5.0	U	5.0	U	5.0	U	5.0	U
Calcium	114000.0		88600.0		48900.0		80900.0		267000.0	R	42900.0	R	104000.0		28300.0		55500.0		82000.0	
Chromium	124.0		144.0		67.6		112.0		40.0	U	40.0	U	10.6		18.6		2520.0		37.6	
Lead	33.8		8.3		10.6		10.2		190.0	U,UJ	190.0	U,UJ	3.0	U	13.7		4.8		7.2	
	35900.0		30500.0		13900.0		24000.0		61000.0	R	4770.0		30600.0		6550.0		14700.0		25100.0	
	417.0		298.0		156.0		457.0						71.8		476.0		308.0		417.0	
Mercury	0.20	U	0.20	U	0.20	U	0.20	U	0.858	B	0.200	U	0.20	U	0.20	U	0.40		0.20	U
Sodium	45100.0		43300.0		9810.0		39400.0		138000.0	R	33100.0	R	30600.0		73700.0		43600.0		28500.0	

Analyte	Well MW-24 (53–73 ft bgs)		Well MW-5 (106–126 ft bgs)		Well MW-6 (117–137 ft bgs)		Percolation Pond Well B (180–182 ft bgs)		Well PW-1 (100–120 ft bgs)		Well PW-2 (111–131 ft bgs)		Well PW-4 (110–150 ft bgs)		Well PA-5 (109–129 ft bgs)		Sewage Treatment Lagoon A (26 ft bgs) Lysimeter Data		HLLW Tank Farm Well A (34.5 ft bgs) Lysimeter Data		HLLW Tank Farm Well B (118ft bgs) Lysimeter Data		USGS 50 (357–405 ft bgs)		USGS 50 (357–405 ft bgs)	
	µg/L	Flags	µg/L	Flags	µg/L	Flags	µg/L	Flags	µg/L	Flags	µg/L	Flags	µg/L	Flags	µg/L	Flags	µg/L	Flags	µg/L	Flags	µg/L	Flags	µg/L	Flags	µg/L	Flags
Cadmium	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	5.0	U	11.5	B,U	25.0	B	10.0	U	5.0	U	5.0	U
Calcium	82500.0		55300.0		64600.0		62000.0		40500.0		46100.0		40800.0		47800.0		163000.0	R	15600.0	R	73300.0	R	71000.0		70700.0	
Chromium	5.0	U	11.3		379.0		69.5		10.9		8.7	B	5.3	B	7.7	B	40.0	U	40.0	U	40.0	U	11.8		13.1	
Lead	3.0	U	3.0	U	10.9		3.1		3.6		3.0	U	3.0	U	3.0	U	190.0	U,UJ	190.0	U,UJ	190.0	U,UJ	3.0	U	3.0	U
Mercury	0.20	U	0.31		0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.20	U	0.200	U	0.200	U	0.200	U	0.20	U	0.20	U
Sodium	61300.0		21000.0		15200.0		136000.0		101000.0		124000.0		100000.0		100000.0		129000.0	R	281000.0	R	92000.0	R	60100.0		59400.0	

Table 6-5. Summary of organic detections.

Location	Depth (ft)	Compound Name	Result Concentration (μg/L)	Qualifier	Sample Number	Date Sample Collected
PW-1	100–120	Methylene chloride	7		PWM13901AV(1)	19-Feb-01
BIG LOST RIVERC	375–385	Carbon disulfide	2	J	PWM15001AV(1)	26-Jun-01
MW-20	133–148	Tetrachloroethene	2	J	PWM13701AV	23-Jul-01
MW-5	106–126	Toluene	2	J	PWM11301AV	12-Jul-01
PW-1	100–120	Carbon disulfide	2	J	PWM13901AV(1)	19-Feb-01
PW-5	109–129	Acetonitrile	66	J	PWM14301AV(1)	21-Feb-01

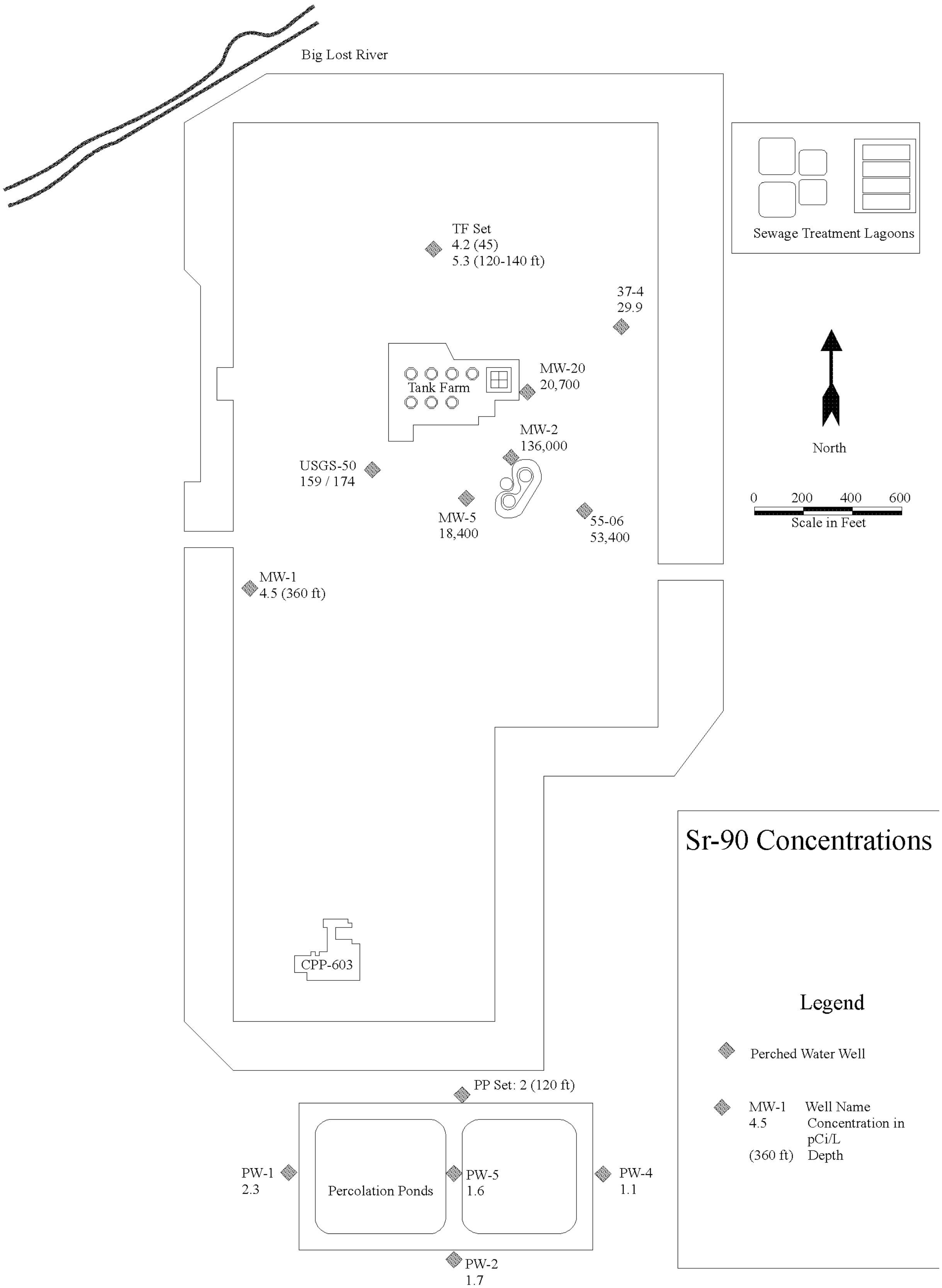

Figure 6-1. Sr-90 concentration by well and depth of sample.

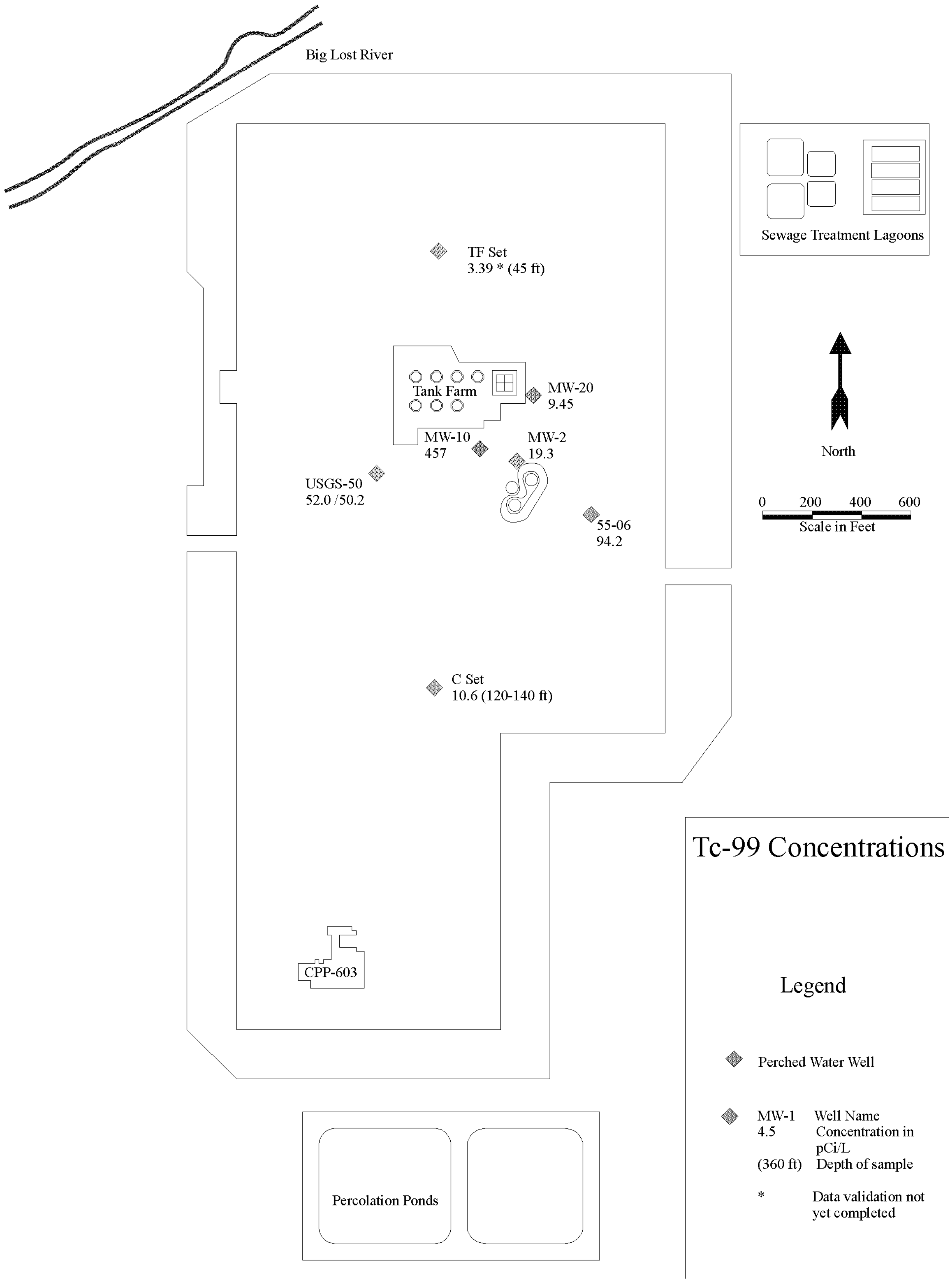

Figure 6-2. Tc-99 concentration by well and depth of sample.

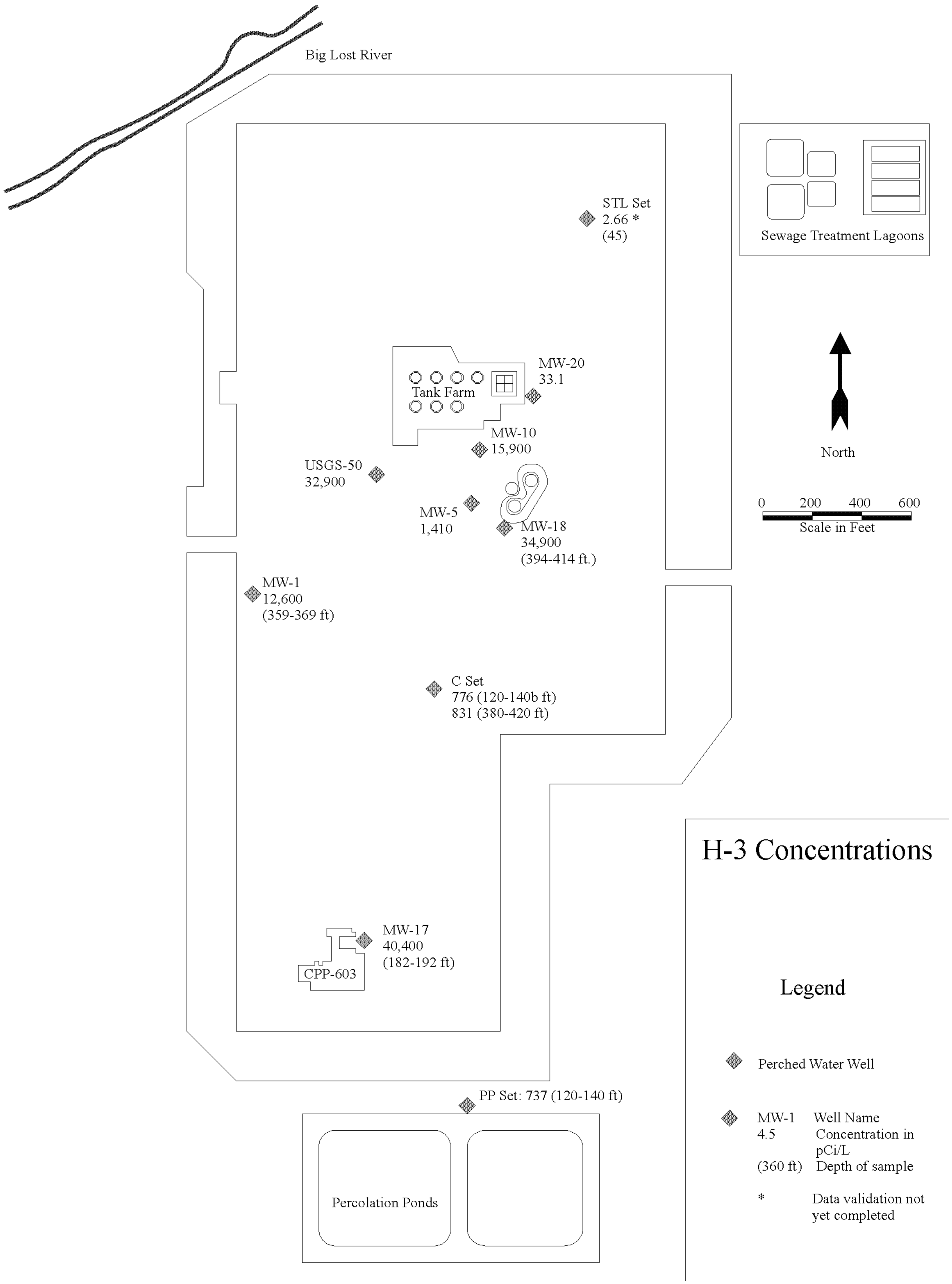

Figure 6-3. H-3 concentration by well and depth of sample.

6.1.1 Northern Shallow Perched Water Contamination

The upper portion of the shallow perched water zone is associated with the C and CD interbeds. Several wells have been constructed to monitor this zone. Historical data are available for comparison from many of the wells constructed from 1990 through 1994.

Prior to the 2000/2001 drilling program, only two wells (MW-10 and -20) were completed in the water-bearing zones of the deeper shallow perched water zone at a depth of approximately 42 m (140 ft). The Group 4, Phase I drilling program of 2000/2001 added an additional eight wells to monitor this zone (that is, wells PP-SP, BLR-SP, CS-SP, TF-SP, CS-CH, PP-CH, STL-CH, and TF-CH). Additionally, samples can be collected from this zone through lysimeters installed in many of the well sets. Table A-3-1 lists the wells added during the most recent drilling program and their construction details.

6.1.1.1 Upper Shallow Perched Zone. The radioactive contamination levels in the highest shallow perched water occurs beneath the northern portion of INTEC, especially in wells MW-2, MW-5, and CPP 55-06. The most significant radionuclides measured in the upper perched water body are Sr-90 and Tc-99. Low levels of H-3 were also detected in the upper perched water zone. The low H-3 concentrations in the upper perched water zone are in significant contrast to the waste stream that was directed to the INTEC disposal well, where the vast majority of the associated radioactivity consisted of H-3. Sr-90 was detected in all wells completed in the northern area of the upper perched water zone. The maximum Sr-90 concentration detected was 136,000 pCi/L (well MW-2) followed by 53,400 pCi/L (well 55-06) and 18,400 pCi/L (well MW-5). Well MW-20 also contained elevated Sr-90 but is completed into the lower shallow water zone. Tc-99 was also detected in the upper perched groundwater. Historically, Tc-99 has been detected in all wells except CPP 33-4 and MW-6. The maximum Tc-99 concentration found in the upper shallow perched water zone is 94.2 pCi/L observed in well 55-06. Higher concentration levels of Tc-99 have been detected in the lower portion of the shallow perched water.

The chemical constituents in the perched water that were detected above a federal primary drinking-water standard (MCL) include nitrate and chromium. Concentrations of these constituents are listed in Table 6-6.

Table 6-6. Wells and concentration exceeding a primary MCL.

Well Name	Nitrate (MCL 10 mg/L)	Chromium (MCL 50µg/L)
37-4	27.9	124.0
55-06	22.4	144.0
Central Set Well B (120-140)		112.0
MW-1 (326-336)	60.3	
MW-24	12.2	
USGS-50	36.5	
Big Lost River Well C (380-420)		67.6
MW-2		2520.0
MW-6		379.0
Percolation Pond Well B (120-140)		69.5

6.1.1.2 Lower Shallow Perched Zone.

Prior to the Group 4, Phase I drilling program of 2000/2001, only two wells (MW-10 and -20) were completed in the water-bearing zone of the lower shallow perched water zone at a depth of approximately 42 m (140 ft). The 2000/2001 drilling program drilled and constructed wells PP-SP, BLR-SP, CS-SP, TF-SP, CS-CH, PP-CH-1, STL-CH-2, and TF-CH in this zone. The maximum concentrations for H-3, Sr-90, and Tc-99 from wells in this zone are 15,900 pCi/L (MW-10), 20,700 pCi/L (MW-20), and 457 pCi/L (MW-10), respectively. A comparison of the water quality from the wells completed in the upper shallow perched groundwater body (at approximately 33 m [110 ft]) to this deeper zone indicates an increase in both H-3 and Tc-99 concentrations and a decrease in the Sr-90 concentrations.

6.1.2 Southern Shallow Perched Water Contamination

Wells that monitor the perched water quality in the upper southern perched water zone around building CPP-603 include MW-7, -9, -13, -14, -15, -16, and -17. The only well sampled from the CPP-603 area was MW-17. H-3 was detected in the 55.5-to-58.5-m (182-to-192-ft) bgs zone at 40,400 pCi/L. Historically, Sr-90, U-234, and Tc-99 have also been detected in other CPP-603 wells when sufficient water was available for sampling.

Perched water in the percolation pond area is monitored by six previously existing wells designated as PW-1 through -6. An additional well (PP-SP) was installed on the north boundary of the percolation ponds during the Group 4, Phase I drilling program. Table A-3-1 describes these wells and their completion details. The PW series wells have been monitored by the USGS since 1987. Wells PW-1, -2, -4, and -5 have been sampled on a quarterly basis as part of the INTEC groundwater-monitoring program since 1991 (INEEL 1995).

Most of the historical radioactivity present in the PW-series wells is from H-3, with Sr-90 providing a secondary activity contribution. According to the USGS monitoring, activities from both H-3 and Sr-90 have remained relatively stable with the exception of an increased H-3 activity period in mid-1988. Historical H-3 concentrations ranged from 1,334 ±421 to 4,681 ±567 pCi/L, with Sr-90 concentrations averaging 3.7 ±3.4 pCi/L. Data from the 2001 sampling indicate H-3 concentrations ranging from non-detects in most of the PW series wells to a high of 737 pCi/L measured in the Percolation Pond Well B at a depth of 36.6 to 42.7 m (120 to 140 ft) bgs. Sr-90 concentrations ranged from non-detects to 2.37 pCi/L.

6.1.3 Lower Perched Water Contamination

Contamination in the lower portion of the vadose zone is different in composition from the upper perched zone. Prior to the drilling program in 2000/2001, the lower perched water was only monitored at INTEC by wells MW-1, MW-17, MW-18, and USGS-50, which are completed in water-bearing zones occurring at depths between 99.4 to 102.4 m (326 to 336 ft), 109.7 to 116.1 m (360 to 381 ft), 120.1 to 126.2 m (394 to 414 ft), and 109.7 to 123.4 m (360 to 405 ft), respectively. Historically, two rounds of perched water samples have been collected from MW-1, one round of perched water samples has been collected from MW-17 and -18, and a substantial database concerning radioactive contaminants is available for the water quality from USGS-50. Results from these water-sampling events are described in the WAG 3 RI/FS work plan (INEEL 1995).

Additional wells were constructed to obtain samples from the lower perched water during the Group 4, Phase I drilling program of 2000/2001. One deep perched water well was constructed at each of the well set locations(BLR-DP, STL-DP, PP-DP, CS-DP, and TF-DP). Table A-3-1 provides the details of the wells and well completion zones.

The most significant radionuclides in the lower perched water body are Sr-90 and Tc-99. Levels of H-3 were also detected in the lower perched water zone. The higher H-3 concentrations in the lower perched water zone are likely associated with the waste stream that was directed to the INTEC disposal well, where the vast majority of the associated radioactivity consisted of H-3 or was due to preferential movement/absorption of some contaminants. The maximum Sr-90 concentration detected was 174 pCi/L in USGS-50. The maximum H-3 concentration detected was 34,900 pCi/L detected in well MW-18 followed by 32,900 pCi/L in USGS-50 and 12,600 pCi/L in MW-1.

Figures 6-1 through 6-3 show the location of the perched water wells and the levels of measured chemical contaminants in the perched water zones. Tables 6-2 through 6-4 summarize data from the water sampling of perched water wells. Complete data from the water sampling are provided in Appendix C.

6.2 Alluvium and Interbed Sediments

Samples were collected from the base of the alluvium and from the interbed materials. The interbed samples were typically collected from near the top of the interbed and directly under the uppermost hydrological properties sample. Data for selected radiological and chemical contaminants are highlighted in Tables 6-7 through 6-9. The complete listing of results from alluvium and interbed sediments is presented in Appendix C.

Table 6-7. Summary of key parameters for radiological chemistry for alluvial and interbed sediments collected during drilling activities.

	I-129 (pCi/g)			Sr-90 (pCi/g)			Tc-99 (pCi/g)			Tritium (pCi/g)		
	Result	C.E.	Q Flags	Result	C.E.	Q Flags	Result	C.E.	Q Flags	Result	C.E.	Q Flags
Central Set Core Hole	2.35E-02	1.06E-01	U	2.68E-01	5.30E-02		-1.40E+00	6.35E-01	U	1.29E+00	3.02E+00	U
Big Lost River-A-Core Hole	6.49E-02	1.06E-01	U	4.10E-02	5.76E-02	U	-5.83E-01	5.52E-01	U	-1.03E+00	2.79E+00	U
Sewage Treatment Lagoon-A-Core Hole	-1.19E-01	1.04E-01	U	1.86E-02	3.35E-02	U	-2.36E+00	1.51E+00	U	-1.32E-01	2.76E+00	U
Tank Farm Core Hole	-1.68E-01	1.02E-01	U	7.22E-02	4.22E-02	U	-2.98E-01	9.81E-01	U	1.46E+00	3.10E+00	U
Percolation Pond-A-Core Hole	6.00E-03	9.45E-02	U	-1.60E-02	2.87E-02	U	-5.42E-01	5.58E-01	U	6.25E+00	3.20E+00	U

Table 6-8. Inorganic chemistry for alluvial and interbed sediments collected during drilling activities.

	CS–CH (376–377.5 ft bgs)		CS–CH (164.2 ft bgs)		STL–CH (104 ft bgs)		STL–CH (385 ft bgs)		PP–CH (384 ft bgs)		PP–CH (111.45 ft bgs)		PP–CH (168 ft bgs)		BLR–CH (87.5–88 ft bgs)		TF–CH (144.6–152.2 ft bgs))	
Analyte (mg/Kg)	Results	Flags	Results	Flags	Results	Flags	Results	Flags	Results	Flags	Results	Flags	Results	Flags	Results	Flags	Results	Flags
Bromide	39	U	39	U	39	U	39	U	38	U	37	U	39	U	22.5	U	40	U
Chloride	40.0		39	U	39	U	39	U	38	U	42.5		88.6		32.5		40	U
Fluoride	39	U	39	U	116		39	U	116		45.5		39	U	64.3		58.0	
Nitrate-N	39	U, R	44.5	U, R	39	U, R	39	U, R	38	U, R	37	U, R	39	U, R	84.6	R	40	U, R
Nitrite-N	39	U, R	39	U, R	39	U, R	39	U, R	38	U, R	37	U, R	39	U, R	22.8	R	40	U, R
Phosphate	39	U, R	39	U, R	39	U, R	39	U, R	38	U, R	37	U, R	39	U, R	22.5	U, R	40	U, R
Sulfate	39	U	62.2		39	U	39	U	38	U	37	U	39	U	97.6	R	40	U

Table 6-9. Summary of key metals analytical results from alluvial and interbed sediments collected during drilling activities.

Analyte	Percolation Pond B (Below Top)		Sewage Treatment Lagoon C (Below Top)		Tank Farm Well B (Below Top)		Percolation Pond CH (Below Top)		Percolation Pond C (Below Top)		Big Lost River B (Below Top)		Central Set B (Below Top)		Central Set C (Below Top)		Sewage Treatment Lagoon B (Below Top)		Percolation Pond A (Below Top)	
	mg/Kg	Flags	mg/Kg	Flags	mg/Kg	Flags	mg/Kg	Flags	mg/Kg	Flags	mg/Kg	Flags	mg/Kg	Flags	mg/Kg	Flags	mg/Kg	Flags	mg/Kg	Flags
Cadmium	0.49	U	0.48	U	0.41	U	0.42	U	0.49	U	0.40	U	0.49	U	0.43	U	0.49	U	0.08	UJ
Calcium	35600		3960		14000		6460		7460		44800		3970		6090		23600		14900	J
Chromium	37.2		21.1		28.0		18.5		63.0	J	22.2		12.8		28.5		43.3		18.5	
Lead	11.7		2.9		11.0		6.3		10.1		11.7		1.9		12.3		16.9		13.2	
Mercury	0.08	U	0.08	U	0.08	U	0.08	U	0.05	U	0.10	U	0.07	U	0.07	U	0.09		0.03	U
Sodium	722		1050		185		1240		743		322	B	931		242	B	384		5930	B, J

Analyte	Central Set CH (Below Top)		Sewage Treatment Lagoon A (Below Top)		Big Lost River A (Below Top)		Tank Farm A (Below Top)	
	mg/Kg	Flags	mg/Kg	Flags	mg/Kg	Flags	mg/Kg	Flags
Cadmium	0.06	UJ	0.05	UJ	0.06	UJ	0.06	UJ
Calcium	9540	J	11100	J	17300	J	14300	J
Chromium	36.8		36.0		15.9		27.9	
Lead	0.26	U	0.25	U	0.26	U	1.00	
Mercury	0.02	U	0.02	U	0.02	U	0.02	U
Sodium	1670	B, J	1550	B, J	3430	B, J	2450	B, J

7. TRACER TEST

7.1 Background

The OU 3-13 ROD (DOE-ID 1999), signed in October 1999, states that the selected remedial action for Group 4 perched water is to implement aquifer recharge controls at INTEC, thereby reducing contaminant flux into the SRPA. In order to accomplish this, a tracer test was designed to help define flow conditions from the major recharge sources to the INTEC perched water zones and the SRPA. According to the ROD, the four largest recharge sources to the INTEC perched water (along with their estimated recharge to the perched water) are the service wastewater (percolation ponds) (2,611,934 m^3/yr [690,000,000 gal/yr]), the BLR (766,789 m^3/yr [202,564,301 gal/yr]), precipitation infiltration (245,890 m^3/yr [64,957,269 gal/yr]), and the sewage treatment lagoons (56,683.6 m^3/yr [14,974,228 gal/yr]). Other sources of recharge to the perched water include water system leaks (15,040.2 m^3/yr [3,973,202 gal/yr]), landscape irrigation (4,919 m^3/yr [1,299,470 gal/yr]), steam condensate (6,315.3 m^3/yr [1,668,327 gal/yr]), and the CPP-603 basins (186.5 m^3/yr [49,275 gal/yr]) (DOE-ID 1999).

Aside from precipitation infiltration that cannot be readily traced because it generally occurs evenly over wide areas, the most significant sources of perched water recharge are the INTEC percolation ponds, the BLR, and the INTEC sewage treatment lagoons. Together, these sources are estimated to supply over 90% of the recharge. Because these three sources supply most of the recharge, knowledge of their behaviors in the subsurface is crucial for draining out the perched water, reducing contaminant flux to the SRPA, and calibrating the vadose zone transport model.

Documents guiding this activity include the tracer test plan (DOE-ID 2000c), the quality assurance project plan (DOE-ID 2000e), the field sampling plan (DOE-ID 2000b), the long-term monitoring plan (DOE-ID 2000d), the waste management plan (DOE-ID 2000f), the health and safety plan (INEEL 2000), the data management plan (DOE-ID 2000e), the quality level designation plan, the spill prevention/response plan, and the stormwater pollution prevention plan.

7.2 Objectives

The objectives of the tracer test are:

1. Determine the flow conditions between the major recharge sources, the perched zones beneath the site, and the SRPA

2. Determine travel time to the perched water zones and to the SRPA

3. Determine contributions that the major recharge sources make to the perched aquifers beneath the site

4. Determine the degree of mixing of recharge waters reaching the perched zones beneath the site

5. Determine the rate of drain out of the perched water zones

6. Determine the rate of contaminant flux to the SRPA

7. Provide data to calibrate the vadose zone transport model.

7.3 Previous and Future Tracer Studies

The tracer test plan (DOE-ID 2000c) describes previous tracer studies conducted at INTEC. In the future, the USGS plans to introduce 1,5-naphthalene disulfonate into the BLR upstream of INTEC when flows in the adjacent river channel are sufficient.

7.4 Summary of Test Design

The initial tracer test design is described in the tracer test plan (DOE-ID 2000c). Of necessity, the design was flexible, allowing logistical adjustments due to field conditions, equipment problems, personnel availability, and other unforeseen events. This section summarizes test design information from the original plan and describes adjustments made during the course of the project. Overall tracer test logic and timing of activities are presented in Figure 4-1 in the original plan.

7.4.1 Tracer Quantity and Introduction

The types and quantities of dye used for the INTEC tracer test were determined by Ozark Underground Laboratory (OUL) based on its experience designing and conducting groundwater-tracing studies. OUL has conducted about 1,000 subsurface traces in perched aquifers and in other settings that are similar to conditions encountered at INTEC. The criteria for tracer selection were described in the tracer test plan (DOE-ID 2000c).

As of December 2001, two dyes (eosine and rhodamine WT) have been used in the study, each introduced into a different area to characterize water movement from surface water resources into the perched aquifer and ultimately into the SRPA. A third dye introduction, fluorescein, was planned for the BLR adjacent to the facility; however, the lack of flow in the channel at that location prevented this activity.

At approximately 5:50 p.m. on June 11, 2001, 27 kg (60 lb) of rhodamine WT dye mixture containing approximately 20% dye and 80% diluent (de-ionized water) was poured into a seepage trough (the trough second from the north end of the set) at the INTEC sewage treatment plant. The dye was shipped to the INEEL in liquid form. Four percolation trenches used for wastewater discharge are located east of the wastewater treatment lagoons in the northeast corner of the INTEC site. Discharge typically rotates weekly among the four trenches. One week before dye introduction, discharge of approximately 38 L/min (10 gal/min) of wastewater entered the trench described above. After dye introduction, discharge continued in this trench for about two weeks. Normal discharge rotation resumed after this period.

At 6:40 p.m. on June 11, 2001, 18 kg (40 lb) of eosine dye mixture containing approximately 75% dye and 25% diluent (de-ionized water) was poured into the inlet trough at "Pond 1" of the INTEC percolation ponds. There are two percolation ponds at the south end of the INTEC area; however, dye was introduced into only one of the ponds, because only one pond is used at a time. Additionally, OUL suggested that the best dye introduction approach was to have a pulse of dye followed by a continuing flush of water. Eosine dye was shipped to the INEEL in eight 20-L (4.5-gal) carboys as a dry powder; each carboy contained approximately 2.25 kg (5 lb) of dye. Water (diluent) was added to the carboys onsite and mixed. Before the dye was introduced, flow entering Pond 1 was diverted to Pond 2 until Pond 1 drained. Water was then diverted back to Pond 1 for approximately 1 hr to re-wet all surfaces. The dye mixture was introduced, and water was discharged to Pond 1 for about one week. After this period, the discharge was diverted to Pond 2 until most of the visually discolored water in Pond 1 had infiltrated. Later, the discharge was diverted back to Pond 1. All water delivered to the percolation ponds for at least the next seven days was discharged into Pond 1.

7.4.2 Tracer Sampling Strategy

7.4.2.1 Tracer Detection. The detection of eosine and rhodamine WT dyes is accomplished in two ways. Tracer detection relies primarily on activated carbon samplers that adsorb and retain both dyes. These are cumulative samplers; therefore, the concentration of dye from a sampler is commonly in excess of the maximum concentration ever present in the water being sampled. The secondary approach is to collect and analyze grab samples of water. The water samples provide dye concentration information at particular points in time. However, sole reliance upon grab samples requires very frequent sampling to ensure that short-duration pulses of tracer dyes are not missed. Furthermore, small dye concentrations may be missed when only grab samples are used. Monitoring wells are neither pumped nor purged prior to sampling.

Packets of granular activated carbon (GAC) were placed to ensure they were submerged in water and next to the open screen (if the well was screened). A cord attached to both the top of the wellhead and to the sampler prevents accidental loss down the well. For screened wells, the GAC sampler is routinely placed approximately 1.5 m (5 ft) below the water table or within any water present in the well. In aquifer wells, the sampler is suspended approximately 4.6 m (15 ft) below the water table. For open-hole wells, the sampler is placed about the midpoint of the water-filled portion of the well. The carbon samplers are typically weighted and suspended with a line in the wells. The bailers remain at the top of the wells during the course of the GAC sampling. Samplers in wells may be temporarily removed to accommodate routine water quality sampling events. Samplers placed at control stations are typically placed in flowing water (or where the water may sometimes be flowing). The samplers are firmly anchored in place with wire or light nylon cord and weighted in place; bricks are commonly used for weights. Wire or cord used to anchor samplers is typically selected or treated so that it is not visually obvious.

One carbon sampler is placed at each monitoring station. At control stations, at least two independently anchored samplers are placed to minimize risk of sampler loss. To the extent possible, both control station samplers are placed in similar settings so they will produce similar analytical results. Production wells CPP-1, -2, -4, and -5 are sampled in the water treatment plant building from hose bibs coming off of pressure tanks. Samplers are held in place with lined metal buckets and experience continuous flow during the sampling period.

When carbon samplers are collected, new samplers are placed. Collected samplers are put in sterile plastic (Whirl-Pak) bags. The bags are labeled on the outside using a black Sharpie permanent marker (other markers have dyes associated with their ink). The sampling station number and name, date, and time collected are recorded on the outside of the bag and on a chain-of-custody form. This folded sampler is the one processed for analysis. After being retrieved from the wells, samplers are put on ice (or Blue Ice) and remain refrigerated at approximately 4° C until analysis.

Grab samples of groundwater are collected each time a carbon sampler is changed, unless no water is present. The bailer is lowered into the well and allowed to fill. The bailer is then withdrawn, and the water sample is placed in a 50-mL vial made of research-grade polypropylene copolymer (Perfector Scientific Catalog Number 2650). Each vial is labeled with the station number and name, date, and time collected, and the same information is recorded on a chain-of-custody form. Grab samples are stored in darkness to prevent photodecomposition of any dyes that might be present in the sample. Samples are placed on ice (or Blue Ice) upon collection and stored at 4° C until analysis.

All grab samples collected are subjected to analysis, even if dye is not detected in the associated carbon sampler.

7.4.2.2 Tracer Analysis. Dye analysis is performed in an on-site field laboratory with a Shimadzu RF5301 Spectrofluorophotometer. Raw data are submitted electronically to OUL for processing and analysis. Sections 7.5 and 7.6 provide a more detailed description of tracer analysis.

7.4.2.3 Sampling Stations. Table 7-1 lists the wells or sampling stations monitored during the tracer study. These wells were categorized into three types: wells that intersect the perched aquifer, wells that intersect the SRPA, and control stations. There are a total of 99 sampling stations: 22 perched aquifer wells that were most likely to contain water at the time of the tracing study, nine additional perched aquifer wells that were drilled before the tracing test, 23 perched aquifer wells that were unlikely to contain water at the time of the tracing study, 40 deep aquifer wells (one that is reportedly dry), and five control stations. Wells in which water was not expected were sampled on a limited basis.

Wells MW-17 (screened between 55.5 and 58.5 m [182 and 192 ft] bgs) and the Percolation Pond Set A, B, and C (screened between 71.6 and 77.7 m [235 and 255 ft] bgs), which are located near the percolation ponds, were sampled three times during the week prior to dye introduction. During the first week after dye introduction, these wells were sampled twice daily. During the following week, the wells were sampled once daily for seven days. During the third week after dye introduction, the wells were sampled four times. All sampling following this period occurred once per week.

This sampling scheme, approved by the Agencies, was undertaken in place of Monitoring Approach 2 (Section 7.4.2.6 of this document), which was to include automatic water samplers. These samplers were unavailable at the time of the tracer test.

7.4.2.4 Background Sampling. The previous use of fluorescent dyes as tracers and the potential for similar dyes that may be associated with disposed liquid wastes required background sampling of INTEC groundwater. On May 16, 2001, sampling began in order to detect the presence of residual fluorescent dyes or compounds with similar fluorescent characteristics. Sampling results showed no eosine or rhodamine WT detections.

7.4.2.5 Tracer Test Duration. The initial planned duration of the tracer study was 25 weeks, assuming that all three dyes were successfully introduced. This proposed test time was based upon past observations of rapid water table rises in several INEEL wells after the initiation of runoff to the BLR (Morris et al. 1963 and Barraclough et al. 1967). Additionally, average vertical water migration rates estimated during the Large-Scale Infiltration Test (LSIT; Wood and Norrell 1996) were determined to be approximately 4.5 to 6 m/day (15 to 20 ft/day). Minimum subsurface migration rates as low as approximately 1 m/day (3 ft/day) were observed during the LSIT.

Sampling for tracer dyes may be discontinued when the following four conditions have been met: (a) sampling has continued at weekly intervals for at least 25 weeks (this includes three weeks of background sampling prior to any dye introduction), (b) sampling for tracer dyes has continued until no new dye recovery stations have been identified during the last three weeks of sampling, (c) sampling has continued until dye concentrations are decreasing at most or all sampling stations, and (d) no other information suggests that sampling should continue.

At present, it has been approximately 35 weeks since eosine and rhodamine WT dyes were introduced and approximately 38 weeks since background sampling began. The original dye introduction was conducted well after the initial spring melt of 2001. This fact, along with low precipitation amounts over the past year, a lack of dye detections in the SRPA, and tracer study results to date, prompted the decision to continue sampling through June 2002. The spring melt of 2002 will increase the chance of dye recoveries in new wells and provide an opportunity to reach more defensible conclusions. Dye introduction into the BLR is postponed until natural flow in the channel occurs. If no natural flow occurs between 2002 and 2005, artificial flow in the channel will be created in 2006 using water from the SRPA.

Table 7-1. Tracer test monitoring stations.

Well Number	Total Depth (ft bgs)	Monitoring Approach	Use Status
Perched water wells likely to contain water (n=22)			
33-2	114.7	1	In use
33-3	126.4	1	In use
33-4	124.0	2	In use
37-4	129.3	1	In use
55-06	122.9	2	In use
MW-01	395.0	1	In use
MW-02	127.0	2	In use
MW-05	141.0	1	In use
MW-06	161.0	1	In use
MW-07	177.0	1	In use
MW-10	181.0	1	In use
MW-15	143.0	2	In use/dry
MW-17S	381.0	2	In use
MW-18P	494.0	1	Dry
MW-20	151.5	1	Dry/in use
PW-1	120.0	1	In use
PW-2	131.0	1	In use
PW-3	123.0	1	In use
PW-4	150.0	1	In use
PW-5	131.0	1	In use
PW-6	135.0	1	Dry
USGS 50	405.0	1	In use
New perched water wells assumed likely to contain water (n=20)			
BLR Set Corehole	406.6	1	In use
BLR Set A	45.0	1	Dry
BLR Set B	140.0	1	Dry
BLR Set C	400.0	1	In use
Sewage Treatment Lagoons Set Corehole	451.0	1	In use
Sewage Treatment Lagoons Set A	45.0	1	Dry
Sewage Treatment Lagoons Set B	140.0	1	Not used
Sewage Treatment Lagoons Set C	400.0	1	In use
Percolation Pond Set Corehole	451.0	1	In use
Percolation Pond Set A	45.0	1	Dry
Percolation Pond Set B	140.0	1	Dry
Percolation Pond Set C	400.0	1	In use
Tank Farm Set Corehole	402.0	1	Dry
Tank Farm Set A	45.0	1	Dry
Tank Farm Set B	140.0	1	Dry
Tank Farm Set C	400.0	1	Dry
Central Set Corehole	402.0	1	Dry

Table 7-1. (continued).

Well Number	Total Depth (ft bgs)	Monitoring Approach	Use Status
Central Set A	46.5	1	Dry
Central Set B	140.0	1	Dry
Central Set C	400.0	1	Dry
Perched water wells unlikely to contain water (n=23)			
33-1	113.6	3	Dry/not used
MW-01P	395.0	3	Dry
MW-03	151.3	3	Dry/in use
MW-03P	151.3	3	Dry/in use
MW-04	131.0	3	Dry/in use
MW-04P	131.0	3	Sometimes dry
MW-07P	177.0	3	Dry
MW-08	141.0	3	Sometimes dry
MW-09	158.0	3	Dry/in use
MW-09P	158.0	3	Dry/in use
MW-10P	181.0	3	Dry
MW-11	150.5	3	Dry/in use
MW-11P	150.5	3	Dry/in use
MW-12	153.0	3	Dry/in use
MW-12P	153.0	3	Dry/in use
MW-13	128.0	3	Dry
MW-14	138.0	3	Dry
MW-16	126.0	3	Dry
MW-17D	381.0	3	In use
MW-17P	381.0	3	Dry
MW-18D	494.0	3	In use
MW-18S	494.0	3	In use
MW-20P	151.5	3	In use
Aquifer wells (n=41)			
CPP-01	585.0	4	In use
CCP-02	605.0	4	In use
CPP-04	700.0	4	In use
MW-18	492.0	4	In use
MW-21	485.5	4	In use
MW-22	585.0	4	In use
USGS-020	472.0	4	In use
USGS-034	700.0	4	In use
USGS-035	578.5	4	In use
USGS-036	567.1	4	In use
USGS-037	571.5	4	In use
USGS-038	729.0	4	In use
USGS-039	572.0	4	In use
USGS-040	678.8	4	In use

Table 7-1. (continued).

Well Number	Total Depth (ft bgs)	Monitoring Approach	Use Status
USGS-041	674.4	4	Not used
USGS-042	678.45	4	Not used
USGS-043	675.8	4	In use
USGS-044	650.0	4	In use
USGS-045	651.21	4	In use
USGS-046	650.86	4	In use
USGS-047	651.3	4	Not used
USGS-048	750.0	4	Not used
USGS-049	656.0	3	In use
USGS-051	659.0	4	In use
USGS-052	650.0	4	Not used
USGS-057	732.0	4	In use
USGS-059	657.0	4	In use
USGS-067	694.0	4	Not used
USGS-077	610.0	4	In use
USGS-082	700.0	4	In use
USGS-085	637.0	4	Not used
USGS-111	600.0	4	In use
USGS-112	563.0	4	In use
USGS-113	564.0	4	In use
USGS-114	562.5	4	In use
USGS-115	581.0	4	In use
USGS-116	580.0	4	In use
USGS-121	745.8	4	In use
USGS-122	482.8	4	Not used
USGS-123	744.2	4	In use
Tank Farm Set D	450.0	4	In use
Control Stations (n =5)			
C-1	BLR @ Lincoln Blvd.	1	In use
C-2	BLR @ railroad	1	In use
C-3	Wastewater treatment plant (outflow)	1	In use
C-4	Percolation ponds (outflow)	1	In use
C-5	Stormwater pit (outflow)	5	In use

7.4.2.6 Description of Monitoring Approach Categories. Table 7-1 lists the monitoring approach used for each well. Before dye introduction, Monitoring Approach 1 wells were sampled three times during background sampling by using activated carbon samplers and collecting grab samples of water. After dye introduction, there were three rounds of sampling during the first week and two rounds of sampling during the second week. At all other times, approximately one round of sampling occurred per week.

Monitoring Approach 2 wells (MW-17 and Percolation Pond Set A, B, and C) were sampled according to the description in Section 7.4.2.3. Thereafter, sampling at these stations followed the same protocol as Monitoring Approach 1.

Monitoring Approach 3 wells were unlikely to contain water during the study. However, water detected in any of these wells was monitored in accordance with Monitoring Approach 1. Monitoring Approach 3 included placement of an activated carbon sampler in the bottom of each well at the start of background sampling. The sampler was recovered on or about the day before dye introduction. A new activated carbon sampler replaced the first sampler at the time of its recovery. Samplers were recovered and replaced about every four weeks unless hydrologic events or some other factor suggested that this schedule should be altered.

Monitoring Approach 4 wells were sampled three times during background sampling by using activated carbon samplers and collecting grab samples of water. After dye introduction, activated carbon and grab samples were collected approximately once per week through the duration of the study.

Monitoring Approach 5 was designated for the INTEC stormwater pit outflow. Only after precipitation adds water to the pit will activated carbon samplers be collected and new samplers placed. Samples from this station will not be collected more frequently than about once per week.

7.4.2.7 Quality Assurance/Quality Control During Sample Collection. Duplicate analysis was planned for about one out of 20 samples. Plans called for two carbon samplers to be placed at CCP-1, PW-1, and PW-4. Due to difficulties associated with placing more than one carbon sampler per well, replicate samples were analyzed rather than duplicate samples (see Section 7.6.4).

7.5 Tracer Analysis

After collection, samples are logged into the Tracer Test Laboratory Trailer (TTLT) by recording respective monitoring station or well location names, dates collected, chain-of-custody numbers, and sample type (water or GAC). Samples are stored at 4° C until analysis. Samples are then prepared and analyzed in the TTLT on a Shimadzu RF5301 Spectrofluorophotometer. Raw data are submitted electronically to OUL for processing and analysis.

7.6 Sample Preparation

Because two types of sample media are collected (grab samples of groundwater and GAC), two methods of sample preparation and analysis are used.

7.6.1 Water Samples

Pre-treatment of water samples is generally not necessary unless the sample is turbid or if there is noticeable coloration from the dye. In that case, the sample is diluted by a factor of 1:100 prior to analysis.

7.6.2 Granular Activated Carbon (GAC) Samples

GAC samples are washed using a pressurized spray of de-ionized water. Washing the samples removes sediments and organic substances from the GAC that could interfere with the fluorescence analysis of each sample. The mesh bag containing the GAC is then opened, and GAC is emptied into a small-lidded plastic cup used for eluting. The wash area and associated equipment are decontaminated between each sample using a solution of 5% bleach in water, then rinsed with de-ionized water.

After washing, the GAC is placed in an eluent solution of 5% aqua ammonia and 95% isopropyl alcohol that is saturated with potassium hydroxide. The aqua ammonia solution is 29% ammonia, and the isopropyl alcohol is 70% alcohol and 30% water. The GAC is left in the solution for 1 hr, at which time the eluent from each sample is decanted into respective 50-mL vials and placed in a refrigerator to chill prior to analysis. Thus, after the GAC samples have been processed by elution, the GAC is no longer needed, and the eluent (which could contain dye) is now the sample in liquid form. If eluent samples present noticeable dye concentrations, they are diluted by a factor of 1:100 or 1:10,000, depending on the intensity of the dye concentration, prior to analysis.

7.6.3 Instrument Analysis

A Shimadzu RF 5301 Spectrofluorophotometer is used to analyze each sample for fluorescence intensity levels and wavelengths. Approximately 2 to 3 mL of sample is placed into a clear cuvette, which is seated in the instrument and subsequently analyzed. The raw data from this analysis are logged, stored, and then transferred to OUL for interpretation and conversion into concentration data.

Water and eluent standards for rhodamine WT and eosine dyes are prepared from standard solutions sent from OUL. Samples, blanks, and standards are chilled in a refrigerator for a minimum of 2 hr before analysis for consistency as well as to maximize dye detection levels.

7.6.4 Quality Control/Quality Assurance During Sample Analysis

One blank sample and one replicate sample is analyzed approximately every 18 samples. Replicate samples are analyzed rather than duplicate samples because of the difficulty posed in placing and retrieving dual samples in sample collection wells. Controls for equipment used in collecting and analyzing samples are also analyzed, including sampling gloves, string, various laboratory equipment, teri wipes, etc.

7.7 Tracer Data

This section contains data results for wells showing detectable dye between May 16, 2001, and September 18, 2001. Eosine was detected in samples from monitoring stations C-3, C-4-NE, PP-CH-2, PP-C-1, PW-1, PW-2, PW-3, PW-4, and PW-5. Rhodamine WT was detected in samples from C-3, MW-24, and STLC. Figure 7-1 shows the monitoring stations sampled in this study. A complete list of sampling and analysis results for this study for samples collected from May 16, 2001, through September 18, 2001, is included in Appendix D. Table D-1 in Appendix D provides the cross references for well names and their aliases used during the tracer study.

7.7.1 Eosine Detections

7.7.1.1 Monitoring Station C-3. C-3 is a control sampling point located in the wastewater treatment plant outflow. There have been two eosine dye detections in this location. Both of the detections have been with GAC samples. Water samples were not collected concurrently with the respective GAC samples. The results are summarized in Appendix D.

7.7.1.2 Monitoring Station C-4-NE. C-4-NE is a control sampling point located in the percolation pond inflow. There have been three eosine dye detections in this location. These detections are likely the results of residual eosine from the initial dye injection. The results for C-4-NE are presented in Appendix D.

7.7.1.3 Monitoring Station PP-CH-2. PP-CH-2 showed an eosine dye detection starting on July 31, 2001. This location shows detections in both GAC and water samples. Results for this location are presented in Appendix D. A plot of dye detections for water samples can be found in Figure 7-2.

7.7.1.4 Monitoring Station PP-C-1. PP-C-1 showed an eosine dye recovery starting on July 9, 2001. This location shows detections in both GAC and water samples. Results for this location are presented in Appendix D. A plot of dye detections for water samples can be found in Figure 7-3.

7.7.1.5 Monitoring Station PW-1. PW-1 showed an eosine dye recovery starting on June 25, 2001. This location shows detections in one GAC sample and four water samples. Results for this location are presented in Appendix D.

7.7.1.6 Monitoring Station PW-2. PW-2 showed an eosine dye recovery starting on June 15, 2001. This location shows detections in both GAC and water samples. Results for this location are presented in Appendix D. A plot of dye detections for water samples can be found in Figure 7-4.

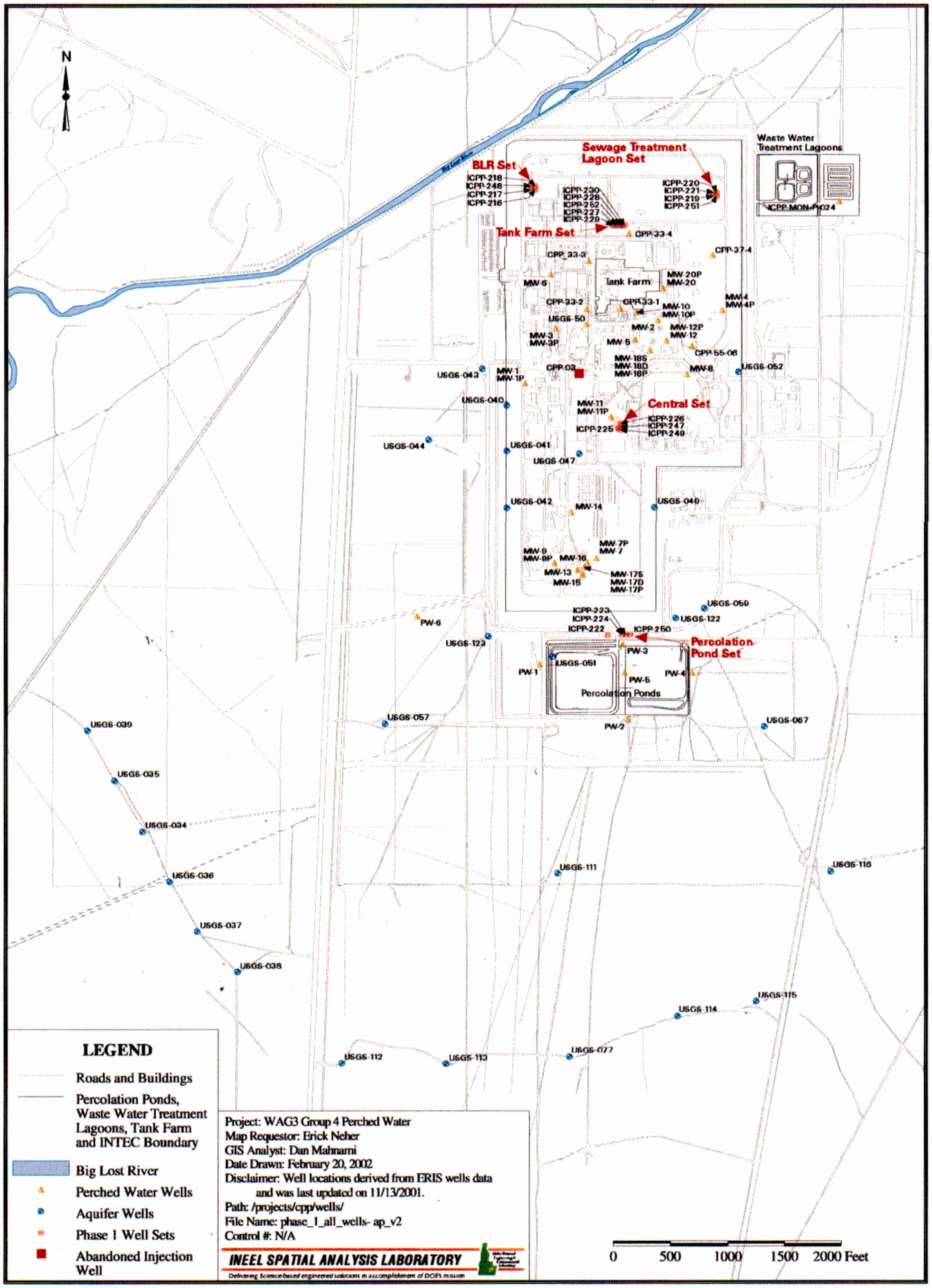

Figure 7-1. INTEC area map showing locations of sampling stations.

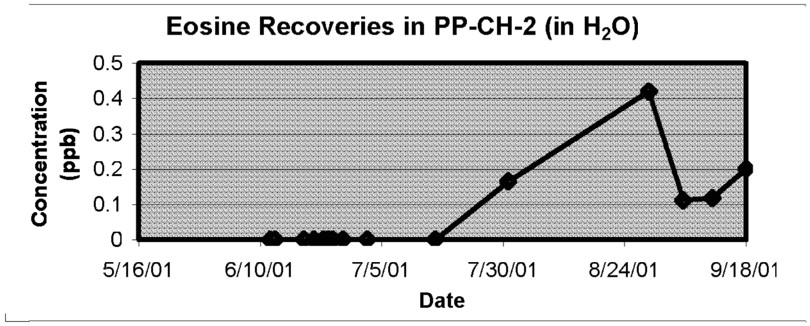

Figure 7-2. Water sample dye detections for well location PP-CH-2

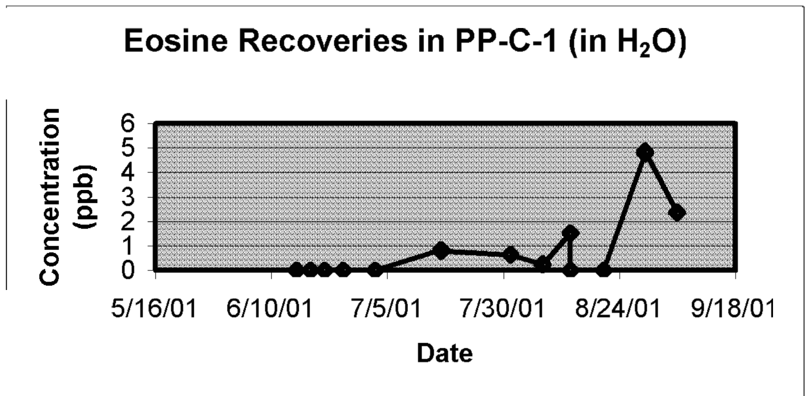

Figure 7-3. Water sample dye detections for well location PP-C-1

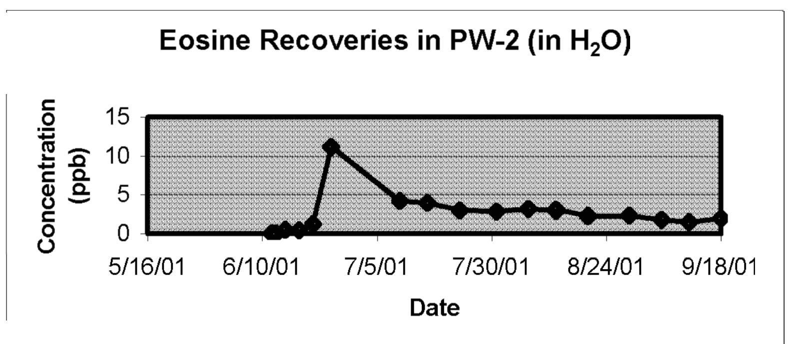

Figure 7-4. Water sample dye detections for well location PW-2.

7.7.1.7 Monitoring Station PW-3. PW-3 showed an eosine dye recovery starting on July 2, 2001. This location shows detections in both GAC and water samples. Results for this location are presented in Appendix D. A plot of dye detections for water samples can be found in Figure 7-5.

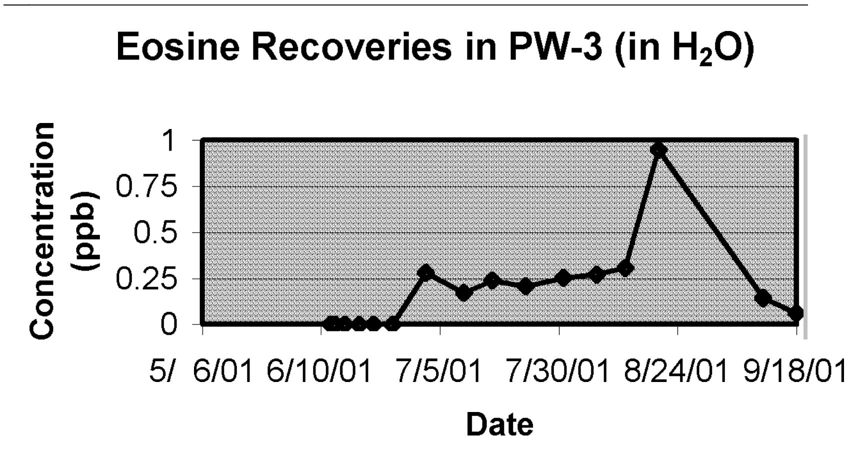

Figure 7-5. Water sample dye detections for well location PW-3

7.7.1.8 Monitoring Station PW-4. PW-4 showed an eosine dye recovery starting on July 24, 2001. This location shows detections in both GAC and water samples. Results for this location are presented in Appendix D. A plot of dye detections for water samples can be found in Figure 7-6.

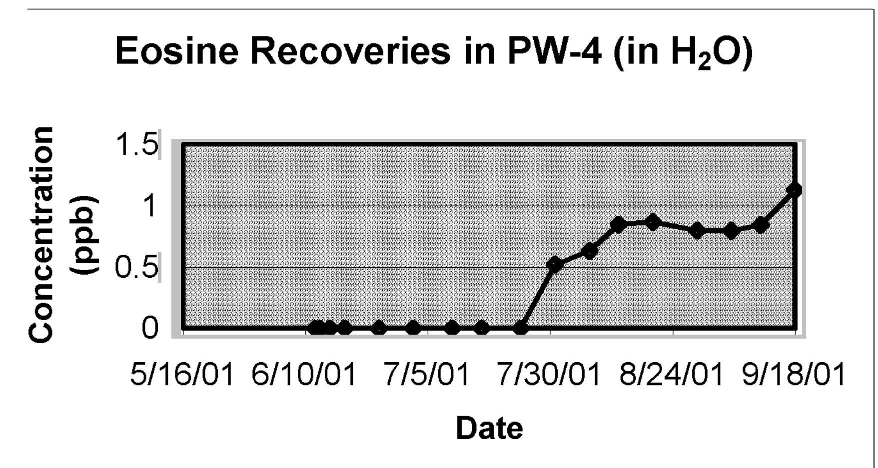

Figure 7-6. Water sample dye detections for well location PW-4.

7.7.1.9 Monitoring Station PW-5. PW-5 showed an eosine dye recovery starting on June 25, 2001. This location shows detections in both GAC and water samples. Results for this location are presented in Appendix D. A plot of dye detections for water samples can be found in Figure 7-7.

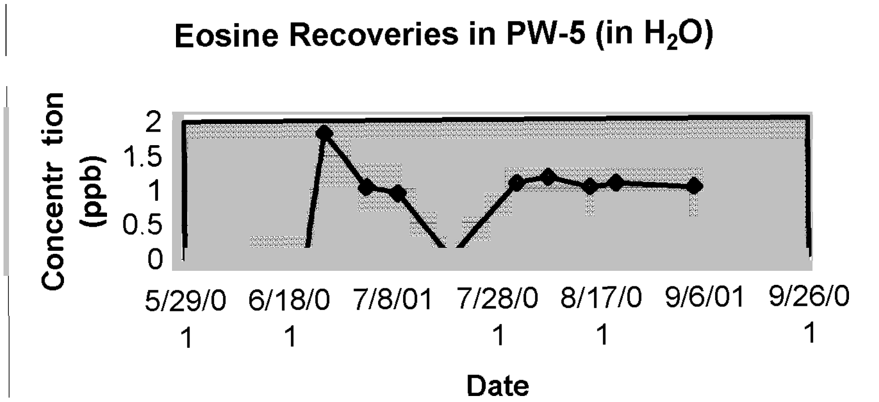

Figure 7-7. Water sample dye detections for well location PW-5.

7.7.2 Rhodamine WT Detections

7.7.2.1 Monitoring Station C-3. Rhodamine WT was first recovered from the C-3 location on June 14, 2001. This location shows detections in both GAC and water samples. The results are summarized in Appendix D.

7.7.2.2 Monitoring Station MW-24. MW-24 showed a rhodamine WT dye recovery starting on June 15, 2001. This location shows detections in both GAC and water samples. Results for this location are presented in Appendix D. A plot of dye detections for water samples can be found in Figure 7-8.

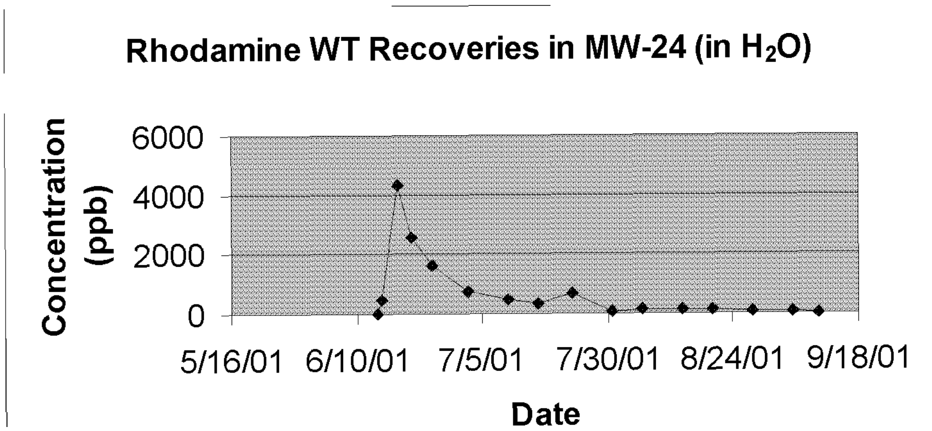

Figure 7-8. Water sample dye detections for well location MW-24.

7.7.2.3 Monitoring Station STL-C. STL-C showed a rhodamine WT dye recovery starting on July 31, 2001. This location shows two consecutive detections in water samples only. Results for this location are presented in Appendix D.

7.8 Perched Water Well Limitations

Eosine detections occurred primarily in perched water wells located in and around the percolation ponds: PW-1 through -6. Of these wells, PW-6 (screened between 32 to 38 m [105 and 125 ft] bgs) was consistently dry during the test period. Water levels and sampling intervals within wells PW-2 and -3 were consistently within the screened intervals of the wells. However, PW-1, -4, and -5, particularly PW-4 and -5, had water levels and sampling intervals well above the screened intervals. (Note: PW-4 and –5 were constructed with deep well screens due to the potential for them to dry up as flow is diverted from the east percolation pond to the west percolation pond). Water levels in PW-4 and -5 ranged between 10 and 14.3 m (33 and 47 ft) above the top of the well screen during the test period. In PW-1, the water level was approximately 2.7 m (9 ft) above the top of the well screen during the test period.

Depth of water sample collection and placement of GAC samplers is dictated by the water levels in the wells, irrespective of screened interval depth. Therefore, measured concentrations of eosine-containing groundwater in PW-1, -4, and -5 may not be accurate time-dependent representations of dye concentrations during the test, because water sampled was above the screened intervals and out of direct connection with the subsurface flow regime in the perched water body. Data from these wells, although reliable in their ability to yield positive concentrations of dye, may not be reliable for calculating flow rates of the dye in the subsurface.

8. DEVIATIONS FROM WORK PLAN AND EVALUATION OF DATA QUALITY OBJECTIVES

This section addresses the status of technical input required to meet project data quality objectives (DQO) as identified in the WAG 3 Group 4 MSIP (DOE-ID 2000a). Additionally, this section summarizes undocumented scope changes during performance of project activities with their respective causes and impacts.

8.1 Data Quality Objectives

The principal study questions (PSQs) in the Group 4 groundwater monitoring DQOs were written to address the large-scale and long-term data requirements of the project. Consequently, an answer to the PSQs will not be provided until after the INTEC percolation ponds have been relocated for a period of five years. This discussion addresses the completeness of data collection for Step 3 of the DQO process, that is, "Identify inputs to the decisions." The status for PSQ-1a, PSQ-1b, and PSQ-3 inputs are listed in Tables 8-1, 8-2, and 8-3, respectively. The inputs to PSQ-2 will be derived from PSQ-1a and PSQ-1b. No additional field data are required for PSQ-2.

Table 8-1. Status of DQO inputs to PSQ-1a.

Required Inputs for PSQ-1a	Status
PSQ-1a. Has the moisture content in the vadose zone beneath Idaho Nuclear Technology Engineering Center (INTEC) been reduced to moisture levels predicted by the WAG-3 OU 3-13 vadose zone model (DOE-ID 10572) within five years following the percolation pond relocation?	
Spatially distributed matric potential measurements from new tensiometers installed within each of subsurface zones at INTEC	Tensiometers were installed in interbeds and at interbed basalt contacts and are currently monitoring matric potential in the subsurface. This monitoring will continue through Phase II.
WAG-3 OU 3-13 vadose zone numerical model derived matric potential action levels for each of the same subsurface zones	This will be evaluated during analysis of the full tracer test data set and reported in a revision to this document in the fall of 2002 (see Section 9, Future Work).
Moisture characteristic curves for the interbed sediments	Moisture characteristic curves were obtained from interbed samples collected during the drilling project.
Injection of tracers of unique fluorescent dyes, which are not currently being used at the INEEL	Unique dyes were used for tracer studies.
Performance of tracer tests to evaluate hydraulic continuity, recharge sources, and travel times	Tracer test is in progress, and results will be reported in a revision to this document in the fall of 2002 (see Section 9).

Table 8-2. Status of DQO inputs to PSQ-1b.

Required Inputs for PSQ-1b	Status
PSQ-1b. Has the COC flux to the SRPA been reduced during the initial 5 years of monitoring following the percolation pond relocation such that water quality in the SRPA meets applicable standards by 2095?	
Collection and chemical analysis for COCs of perched water samples from existing vadose zone monitoring wells	Samples were collected and analyzed from all wells that contained sufficient water to collect a sample.
Collection and chemical analysis for COCs of soil water samples from new and existing lysimeters	Samples were collected and analyzed from lysimeters
Measurement of water levels in existing vadose zone monitoring wells	Water levels are measured on a regular schedule as part of the tracer test sampling program. Following the tracer test, automated water level data loggers will be reinstalled in the monitoring wells that have standing water.
Measurements of tension from new tensiometers.	Tensiometers were installed in interbeds and at interbed basalt contacts and are currently monitoring matric potential in the subsurface. This monitoring will continue through Phase II.
Collection and analysis of interbed sediment samples at locations of new tensiometers for development of moisture characteristic curves and grain size analysis.	Sediment samples were collected and analyzed accordingly.
Collection and chemical analysis for COCs of groundwater samples from new and existing monitoring wells installed in the SRPA.	Baseline sampling under the WAG 3 Group 5 SRPA monitoring program occurred during the spring of 2001, and sample results are available for evaluation with the Group 4 data.
Collection and chemical analysis of tracers in perched water.	Collection and analysis are ongoing
Measurement of water levels in new and existing monitoring wells installed in the SRPA.	Water levels are measured on a regular schedule.
Recharge water source information for precipitation, BLR flows, and facility discharge volumes.	Precipitation, BLR flows, and facility discharge volumes are available.
Incorporation of monitoring data, collected during the five years following relocation of the percolation pond, into the refined WAG 3 OU 3-13 model and calculation of the predicted concentrations of COCs in the SRPA in year 2095 and beyond	In progress.

Table 8-3. Status of DQO inputs to PSQ-3.

Required Inputs for PSQ-3	Status
Based upon new data obtained during evaluation of the percolation pond relocation and an evaluation of recharge sources, is lining of the BLR the recommended alternative if additional recharge controls are necessary?	
Time-series water level and tension measurements in existing monitoring wells and in the Phase I and II wells	In progress.
Time-series data obtained from the National Oceanic and Atmospheric Administration, the USGS, and INTEC operations for information impacting recharge including BLR flow data; precipitation, temperature, and pressure records; and percolation pond, sewage treatment lagoons, and other operational (if required) discharge volumes	The data are available.
Perched water sample collection and analysis for tracers	Collection and analysis are ongoing.
Perched water sample collection and analysis for basic geochemistry	Samples were collected and analyzed from all wells that contained sufficient water to collect a sample.
Collection and analysis of source-term waters for the same suite of analytes as perched water samples	Remains to be completed.

8.2 Deviations from the Field Sampling Plan during Perched Water Well Installation

The following numbered items summarize undocumented field sampling plan (DOE-ID 2000b) changes that occurred during the performance of perched water well installation, the reason for the changes, and any impacts resulting from the changes.

1. **Planned Activity:** The field sampling plan called for installation of 15 wells.

   Actual Activity and Reason for Deviation: An additional corehole was drilled for each well set, and an alluvial well was also installed in the Central Well Set. The original planning called for coring and overreaming of the corehole to provide for the deep perched water monitoring well at each location. However, an evaluation of the cost and technical difficulties involved in overreaming a deep corehole versus drilling a separate borehole lead to the decision to simply install a separate borehole for the deep perched water well at each location. This also allowed for completion of monitoring wells and/or piezometers in the corehole and simplification of the well construction for the other alluvium and shallow perched water wells.

   Identification of a significantly deeper alluvium/basalt contact at the location of the Central Well Set prompted the decision to install an unplanned alluvial well at that set. The presence of an apparent depression in the alluvium/basalt interface indicates the potential for preferential moisture accumulation at this location, making it a desirable location for monitoring of this zone.

Impacts and Consequences of the Deviation: No negative impacts or consequences are expected from this deviation.

2. **Planned Activity:** The field sampling plan specified locations for the Tank Farm and Sewage Treatment Lagoon well sets.

   Actual Activity and Reason for Deviation: The actual location for the Tank Farm Well Set was moved approximately 76 m (250 ft) to the northeast from the original field sampling plan. The Sewage Treatment Lagoon Well Set was moved approximately 30 m (100 ft) to the north from the original field sampling plan. These changes were due to subsurface utility obstructions (Tank Farm Well Set) and future INTEC facility construction (Sewage Treatment Lagoon Well Set).

   Impacts and Consequences of the Deviation: These changes are not expected to negatively affect the ability to measure perched water levels or detect tracer dyes.

3. **Planned Activity:** The field sampling plan called for installing tensiometers, lysimeters, moisture sensors, and piezometers in each borehole.

   Actual Activity and Reason for Deviation: Due to the number of wells at each site and their close proximity to each other, instrumentation was distributed among the wells of each well set. Instrumentation of the shallow wells was not duplicated by instrumentation in the deeper wells.

   Impacts and Consequences of the Deviation: No negative impacts or consequences are expected from this deviation. Within each well set, all subsurface intervals of interest are instrumented.

4. **Planned Activity:** The field sampling plan called for the collection of subsurface sediment from interbeds for testing and archiving.

   Actual Activity and Reason for Deviation: Interbed samples collected were sufficient for all required testing. However, because recovered material was limited and testing was a priority, some interbeds will not be represented in the archive.

   Impacts and Consequences of the Deviation: The lack of archived samples for certain coreholes will have no impact on this study. Future studies may be impacted slightly by the absence of archived samples.

5. **Planned Activity:** The field sampling plan called for geophysical logging of each hole using the following logging methods: video, caliper, natural gamma, deviation, gamma-gamma, density, neutron, and high-resolution gamma spectroscopy.

   Actual Activity and Reason for Deviation: Due to the number of wells at each site and their close proximity to each other, it was decided that the logging of each borehole would be redundant. Certain logging methods were not used prior to well construction due to availability/time constraints. However, in all cases, a video logging to identify high-moisture zones and a natural gamma log to identify interbed zones were performed before well construction.

   Impacts and Consequences of the Deviation: There are no negative impacts or consequences due to this deviation. Borehole logging was intended to be a field tool to aid in the completion of monitoring wells and is not a requirement of the DQOs.

8.3 Deviations from the Tracer Test Plan

The following numbered items summarize changes made to the tracer test plan (DOE-ID 2000c) during performance of project activities, the reason for the changes, and impacts to the project resulting from the changes.

1. **Planned Activity:** Tracer-free water was discharged into the selected sewage treatment plant trench at a minimum rate of 190 L/min (50 gal/min) for 24 hr before dye introduction. After this wetting period, the dye mixture was poured into the trench.

   Actual Activity and Reason for Deviation: Tracer-free water was discharged into the selected trench at the sewage treatment plant at a rate of 38 L/min (10 gal/min) for one week before dye introduction. After dye introduction, wastewater discharge to this trench continued for another two weeks. Normal discharge rotation resumed after this period. The change from expected discharge was due to repairs conducted on the sewage treatment plant and lower-than-normal discharge from the plant as the sewage lagoons refilled and normal operations resumed.

   Impacts and Consequences of the Deviation: No negative impacts or consequences are expected from this deviation.

2. **Planned Activity:** For screened wells, the samplers are routinely placed at a depth equal to the mid-point of the screened interval. The carbon samplers are typically attached to weighted disposable bailers with plastic ties. The bailers remain in the wells during the course of the sampling.

   Actual Activity and Reason for Deviation: In screened wells, the GAC samplers are routinely placed approximately 1.5 m (5 ft) below the water table or within any water present in the well. In aquifer wells, the samplers are suspended approximately 4.6 m (15 ft) below the water table. In open-hole wells, the samplers are placed near the midpoint of the water-filled portion of the well. The bailers remain at the top of the wells during the course of the GAC sampling. Deviations in placement depths of GAC samplers resulted from evaluating actual water level measurements in the wells and making adjustments to accommodate water level fluctuations. Several incidents of bailers and GACs becoming entwined and stuck in the well bore are the reason the sample methods are now separate.

   Impacts and Consequences of the Deviation: No negative impacts or consequences are expected from this deviation.

3. **Planned Activity:** At production wells CPP-1 and -2, samplers are placed in sample holders made of PVC pipe. A flow rate of about 3.8 L/min (1 gal/min) is run through each installed sampler during any period when the well is being pumped. CPP-1 is equipped with two side-by-side sampler holders, each containing one activated carbon sampler. Equal flows of water will be passed through each of these samplers.

   Actual Activity and Reason for Deviation: Production wells CPP-1, -2, -4, and -5 are sampled in the water treatment plant building from hose bibs coming off of pressure tanks. Samplers are held in place with lined metal buckets and experience continuous flow during the sampling period. Logistical simplicity was the reason for this deviation.

   Impacts and Consequences of the Deviation: No negative impacts or consequences are expected from this deviation.

4. **Planned Activity:** The groundwater sampling process begins with withdrawal of the disposable bailer from the well, allowing the water it contains to drain back down into the well. The bailer is then lowered to its normal position in the well and allowed to refill.

   Actual Activity and Reason for Deviation: Grab samples of groundwater are collected each time a carbon sampler is changed, unless no water is present. The bailer, normally stored at the top of the well bore, is lowered into the well and allowed to fill. After withdrawal, the water sample is placed in a 50-mL vial. This modification was made to keep well casings dry and prevent the bailers and the GAC samplers from becoming entangled.

   Impacts and Consequences of the Deviation: No negative impacts or consequences are expected from this deviation.

5. **Planned Activity:** At stations containing two GAC samplers, both are placed in the same bag. If at the time of collection, one of the samplers was observed to be out of the water or if, for some other reason, one sampler appears to have been placed better than the other, the most representative sampler will be folded in half in the sample bag.

   Actual Activity and Reason for Deviation: Due to the small diameter of some of the well casings and the difficulty of placement, only one GAC sampler is installed at a time. Replicate analyses of the carbon samplers were conducted instead of duplicate samples.

   Impacts and Consequences of the Deviation: There are no negative impacts or consequences of this deviation.

6. **Planned Activity:** Automatic water samplers operated for approximately four weeks at five sampling stations, collecting samples once every 8 hr.

   Actual Activity and Reason for Deviation: Automatic water samplers were not used during the tracer, study because commercially available samplers that would operate at the depths of the water encountered in this study could not be found. Available samplers rely on peristaltic pumps that would not operate at depths greater than approximately 8 m (25 ft).

   Impacts and Consequences of the Deviation: There are no negative impacts or consequences due to this deviation.

7. **Planned Activity:** Wells MW-17S and -15, located near the percolation ponds, were monitored from one week prior to any dye introduction to about three weeks after the last dye introduction with automatic water samplers programmed to collect water samples every 8 hr.

   Actual Activity and Reason for Deviation: Well MW-15 was not sampled, because it was dry. Automatic water samplers were not used during the tracer study, because they were not available. Wells MW-17 and the percolation pond corehole (ICPP-SCI-P-250) were sampled three times during the week prior to dye introduction. During the first week after dye introduction, these wells were sampled twice daily. During the following week, the wells were sampled once daily for seven days. During the third week after dye introduction, the wells were sampled four times. All sampling after this period occurred once per week.

   Impacts and Consequences of the Deviation: There are no negative impacts or consequences of this deviation.

9. FUTURE WORK

9.1 Extension of Phase I Activities

The work documented in this report represents the completion of Phase I activities for the OU 3-13, Group 4 remedy as set forth in the Group 4 MSIP (DOE-ID 2000a). Appendix D of the MSIP is the *Tracer Test Plan for Operable Unit 3-13 Group 4, Perched Water* (DOE-ID 2000c) and sets forth a 25-week tracer study that would complete the Phase I field activities (Figure 9-1). However, based on the results of the tracer study to date, the tracer study is being continued through June 11, 2002. The rationale for continuing the tracer study is based on the fact that neither of the tracer dyes injected into the sewage treatment lagoons or the percolation pond has been detected in the SRPA. One of the primary objectives of the tracer study is to, "Determine travel times to the perched water zones and to the SRPA" (DOE-ID 2000c, Section 1.2, p. 1-3). The schedule for the extended portion of the Group 4 tracer study with a reduced frequency of sample collection has been prepared and is shown in Table 9-1.

A revision to this monitoring well and tracer study report will be prepared to document the extended tracer study and completed Phase I activities and data analysis (Figure 9-1). Development of the final revision to the Phase I reporting is planned for the fall of 2002. The report will also provide recommendations for implementing the Phase II drilling and monitoring program, which is currently scheduled for the spring of 2003.

9.2 BLR Tracer Study

During implementation of the Phase I tracer studies in the summer of 2001, no water flowed in the BLR channel adjacent to the INTEC facility. Consequently, BLR tracer studies described in the Group 4 tracer study test plan could not be implemented. As set forth that plan (DOE-ID 2000c, Section 4.2, p. 4-3), dye introductions were performed on the percolation ponds and sewage treatment lagoons, with dye studies of the BLR postponed until flow is again present in the river channel. As established in the tracer test plan, tracer studies will be performed on natural flow in the river channel, if feasible, between the years of 2002 and 2005. Planning for the BLR tracer study will include the monitoring of the BLR drainage snow-pack and Mackay Reservoir levels in order to anticipate when natural flow will occur in advance of the spring runoff. If natural flow has not occurred during that period, tracer studies will be performed with artificial flow in the channel in the year 2006 using SRPA water.

9.3 Groundwater Sampling and Moisture Monitoring

One round of baseline groundwater samples was included in the scope of the Group 4 MSIP (DOE-ID 2000a) (Figure 9-1) during the Phase I activities, and this sampling has been completed. Moisture monitoring and perched water elevation measurements will be continued through the extended Phase I tracer test study.

The Phase II perched water well installation and sampling program, as described in the Group 4 MSIP, will be initiated during the spring of 2003. The well locations for Phase II will be presented in the future revision to this document. The long-term perched water monitoring will be initiated in the year following the relocation of the existing percolation ponds. This is in accordance with the schedule presented in the Group 4 long-term monitoring plan (DOE-ID 2000d, Table 4-4).

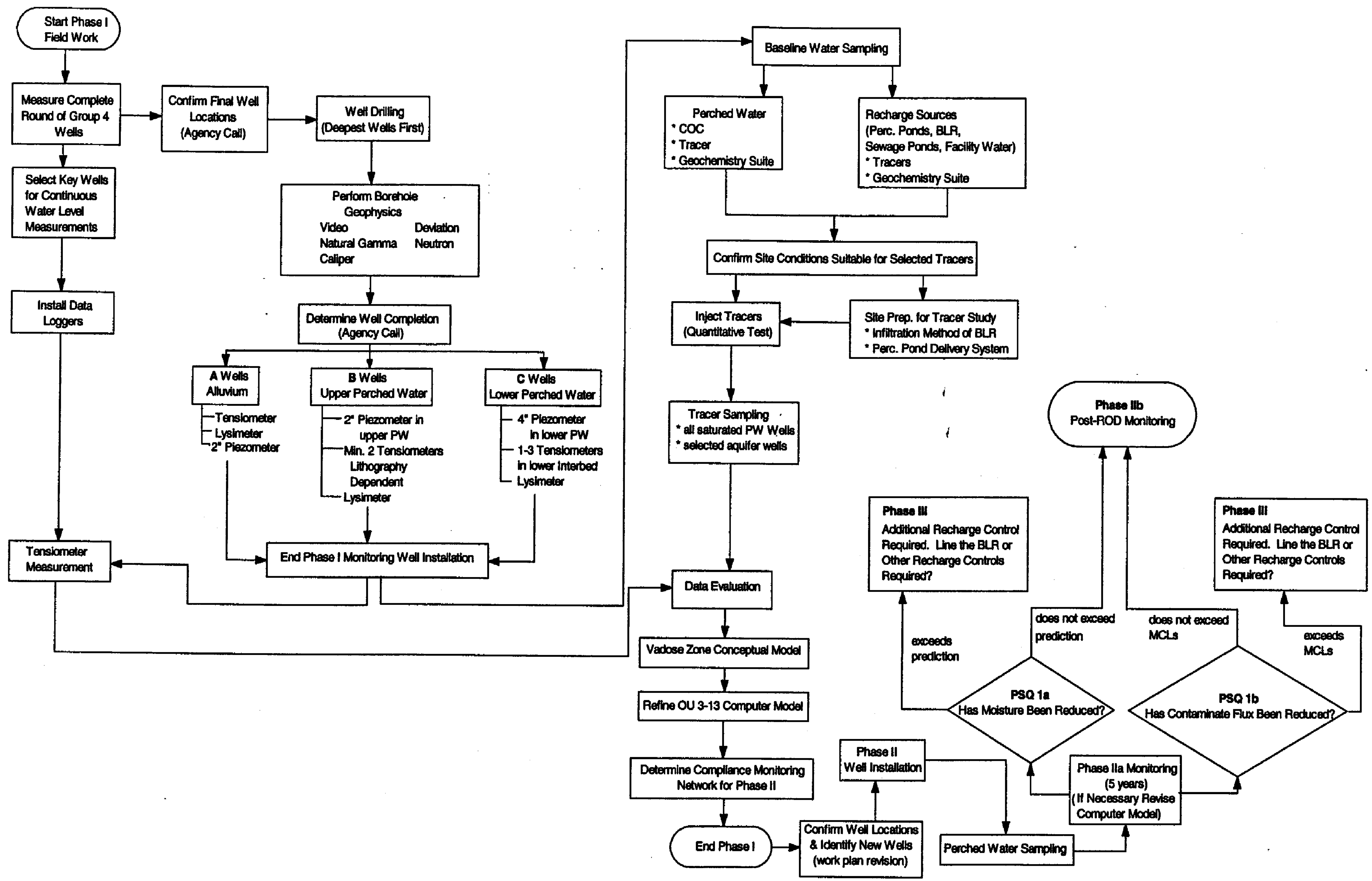

Figure 9-1. Logic diagram for OU 3-13 Group 4 activities.

Table 9-1. Tracer test monitoring stations and sampling frequency.

Well Number	Extended Monitoring Frequency[a]
33-1	Once per month
33-2	Bi-weekly
33-3	Bi-weekly
33-4	Bi-weekly
37-4	Bi-weekly
55-06	Bi-weekly
BLR Set A	Once per month
BLR Set B	Once per month
BLR Set C	Once per month
BLR Core Hole	Once per month
CPP-01 02& CPP-02 (via utilities facility)	Once per month
Central Set B	Once per month
Central Set C	Once per month
Central Set Core Hole	Once per month
CPP-04 (via utilities facility)	Bi-weekly
MW-01 (4)	Once per month
MW-01 (1)	Once per month
MW-02	Bi-weekly
MW-03 (1)	Once per month
MW-03 (2)	Once per month
MW-04 (1)	Bi-weekly
MW-04 (2)	Bi-weekly
MW-05	Bi-weekly
MW-06	Once per month
MW-07 (2)	Bi-weekly
MW-07 (1)	Once per month
MW-08	Once per month
MW-09 (1)	Bi-weekly
MW-09 (2)	Bi-weekly
MW-10 (1)	Once per month
MW-10P (2)	Once per month

Table 9-1. (continued).

Well Number	Extended Monitoring Frequency[a]
MW-11 (1)	Once per month
MW-11 (2)	Once per month
MW-12 (1)	Once per month
MW-12 (2)	Once per month
MW-13	Once per month
MW-14	Once per month
MW-15	Once per month
MW-16	Once per month
MW-17 (4)	Once per month
MW-17 (1.25)	Once per month
MW-17 (2)	Bi-weekly
MW-18 (1.25)	Once per month
MW-18 (2)	Bi-weekly
MW-18	Once per month
MW-20 (2)	Bi-weekly
MW-20 (1)	Once per month
MW-21	Bi-weekly
MW-22	Bi-weekly
MW-24	Bi-weekly
Percolation Pond Core Hole	Bi-weekly
Percolation Pond Set A	Once per month
Percolation Pond Set C	Bi-weekly
PW-1	Bi-weekly
PW-2	Bi-weekly
PW-3	Bi-weekly
PW-4	Bi-weekly
PW-5	Bi-weekly
PW-6	Once per month
Sewage Treatment Lagoons Core Hole	Once per month
Sewage Treatment Lagoons Set A	Once per month
Sewage Treatment Lagoons Set B	Once per month

Table 9-1. (continued).

Well Number	Extended Monitoring Frequency[a]
Sewage Treatment Lagoons Set C	Bi-weekly
Tank Farm Core Hole	Once per month
Tank Farm Set A	Once per month
Tank Farm Set B	Once per month
Tank Farm Set C	Once per month
Tank Farm Set D	Bi-weekly
USGS-50	Once per month
USGS-020	Once per month
USGS-034	Once per month
USGS-035	Once per month
USGS-036	Once per month
USGS-037	Once per month
USGS-038	Once per month
USGS-039	Once per month
USGS-040	Once per month
USGS-043	Once per month
USGS-044	Once per month
USGS-045	Once per month
USGS-046	Once per month
USGS-048	Bi-weekly
USGS-049	Once per month
USGS-051	Bi-weekly
USGS-052	Bi-weekly
USGS-057	Bi-weekly
USGS-059	Bi-weekly
USGS-077	Once per month
USGS-082	Once per month
USGS-085	Once per month
USGS-111	Bi-weekly
USGS-112	Once per month
USGS-113	Once per month
USGS-114	Once per month

Table 9-1. (continued).

Well Number	Extended Monitoring Frequency[a]
USGS-115	Once per month
USGS-116	Once per month
USGS-121	Once per month
USGS-123	Bi-weekly

a. Monitoring frequencies my change based on the presence/absence of water in the well.

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